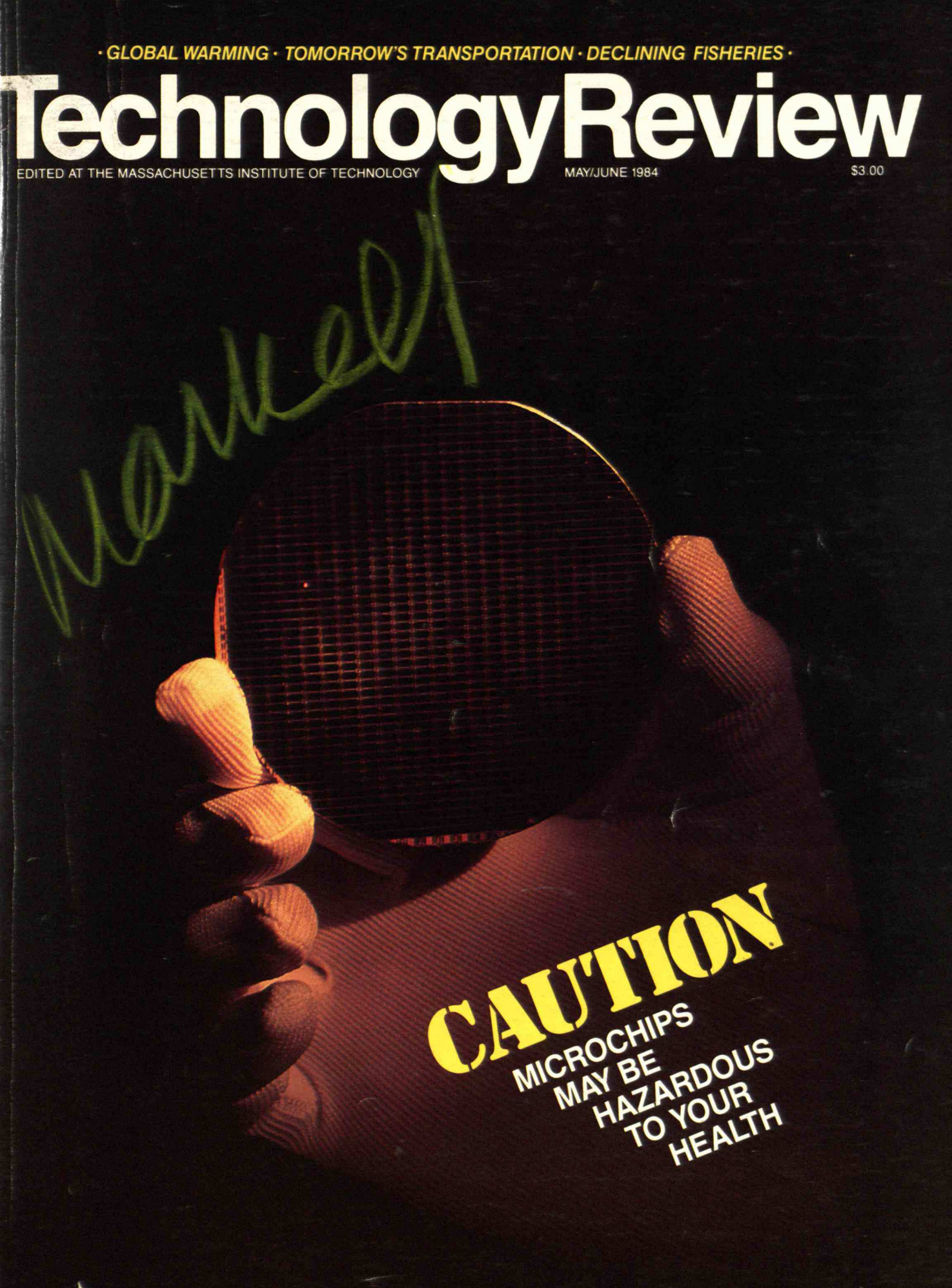
· GLOBAL WARMING · TOMORROW'S TRANSPORTATION · DECLINING FISHERIES ·

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MAY/JUNE 1984

$3.00



CAUTION

MICROCHIPS MAY BE HAZARDOUS TO YOUR HEALTH

technology
review
Published by MIT

Consumer Orientation
No. 27 in a series
Subject: The Porsche philosophy of reliability on the track and in their street cars.

27 Porsche 944

At Porsche, we have always built unusually successful sports cars. Through a high investment in technical excellence, these automobiles have brought home countless racing victories.

Yet, our main objective has never been absolute speed. Performance is not achieved at the expense of safety, reliability, and endurance. This philosophy applies to every automobile we build. Before any prototype goes into production, it is put through a rigorous series of tests at our research facility near Stuttgart, Germany. Here, under demanding conditions, the proper balance in terms of fuel economy,* performance, and driving safety is attained.

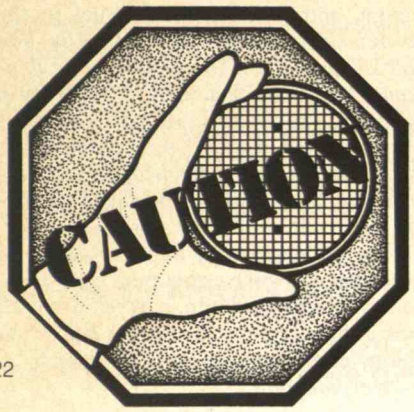
The Porsche 944 represents our latest achievement. Like all its predecessors, it incorporates the knowledge gained from testing and race-honed experience into its design. You see, at Porsche, excellence is expected. The Porsche 944 is priced at $21,440.** For your nearest Porsche Audi dealer call toll free 1-800-447-4700 within the continental U.S.

PORSCHE + AUDI
NOTHING EVEN COMES CLOSE

*EPA estimated 22 mpg, 35 estimated highway. Use "estimated mpg" for comparison. Mileage varies with speed, trip length and weather.
**Mfr's sugg. retail price. Title, taxes, transp., registration and dealer delivery charges additional.

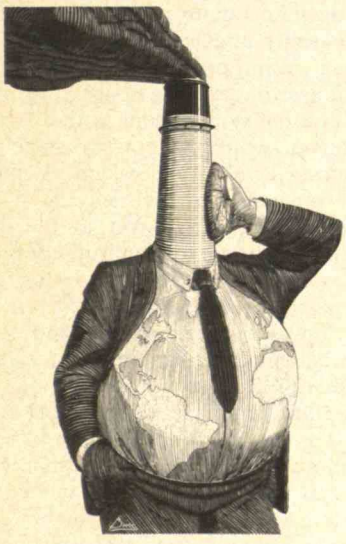
MAY/JUNE 1984 VOL. 87 NO. 4 EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

TechnologyReview



22


38


48

22 **THE NOT-SO-CLEAN BUSINESS OF MAKING CHIPS**
BY JOSEPH LaDOU
The huge quantities of toxic materials used in the microelectronics industry pose far greater health problems than previously realized.

38 **TECHNOLOGY AND FREEDOM IN THE SOVIET UNION**
BY S. FREDERICK STARR
A combination of new technology and changing social mores is encouraging the growth of individual freedom in the Soviet state.

48 **REDUCING THE PROBLEM OF GLOBAL WARMING**
BY DAVID J. ROSE, MARVIN M. MILLER, AND CARSON AGNEW
A new study has highlighted an international strategy to limit the long-term damage from global warming — without requiring major alterations in our patterns of energy use.

60 **MOVING PEOPLE AND GOODS BEFORE THE YEAR 2000**
BY DAVID GORDON WILSON
Present transportation systems will change very little, but new ways of allocating their costs can improve their performance significantly.

68 **SPECIAL REPORT: FISHING**
BY BRUCE D. STUTZ
American fishermen are not gaining the benefits that they expected from new technology and protectionist legislation.

2 **FIRST LINE/LETTERS**

4 **ROBERT C. COWEN**
Efforts to rescue Chesapeake Bay come none too soon.

6 **FORUM**
MARSHALL I. GOLDMAN, HOWARD A. STAFFORD, AND MARK TEMPLER
Three views on what it takes (or doesn't take) to attract high technology to a region.

15 **BOOKS AND COMMENT**
Math education, scientism, and a new economic order.

25 **OCCUPATIONAL HEALTH**
ALISON BASS
State and industry officials in California can't agree on a definition for "instantaneous" — as in instantaneous chemical exposure.

58 **THE GREENHOUSE EFFECT**
DAVID J. ROSE
Two recent reports on global warming differ considerably in tone and emphasis.

80 **TRENDS**
A livable square, places in the sun, what we don't know about chemical hazards, and the risks of research reactors.

COVER
Photograph by Charles O'Rear from West Light
Design by Kathleen Sayre

TechnologyReview

PUBLISHER
William J. Hecht
EDITOR-IN-CHIEF
John I. Mattill
MANAGING EDITOR
Peter Gwynne
DESIGN DIRECTOR
Nancy L. Cahners
DESIGN/
PRODUCTION MANAGER
Kathleen B. Sayre
SENIOR EDITORS
Alison Bass
Tom Burroughs
Jonathan Schlefer
ASSOCIATE EDITORS
Sandra Hackman
Sandra Knight
PRODUCTION/EDITORIAL
ASSISTANTS
Valerie Kiviat
Elizabeth Motzkin
ASSISTANT TO THE EDITORS/
PERMISSIONS
Julie Van Buren

BUSINESS MANAGER
Peter D. Gellatly
CIRCULATION DIRECTOR
Julie Zuckman
SUBSCRIPTION SERVICE MANAGER
Dorothy R. Finnerty
CIRCULATION/ADVERTISING
ASSISTANT
Deborah Gallagher

Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October and November/December) at the Massachusetts Institute of Technology. Two special editions are provided for graduate (pp. A1-A32) and undergraduate (pp. A1-A32 and B1-B16) alumni of M.I.T. Entire contents © 1984 by the Alumni Association of M.I.T. Printed by Lane Press, Burlington, Vt. Second-class postage paid at Boston, Mass. and additional mailing offices. Postmaster: send Form #3579 to M.I.T., Room 10-140, Cambridge, Mass. 02139.

Editorial, circulation, and advertising offices: *Technology Review*, Room 10-140, Mass. Institute of Technology, Cambridge, Mass. 02139 (617) 253-8250.

Advertising representatives:
The Leadership Network: 254 Fifth Ave., New York, N.Y. 10001 (212) 684-5500; Benson Co., Park Ridge, Ill.; Colin Smith Agency, Berkeley, Calif.; Joe DeLone & Associates, Riverside, Conn., and Lincoln, Mass.; and McKeldin Co., Atlanta, Ga.

Littel-Murray-Barnhill, 1328 Broadway, New York, N.Y. 10001 (212) 736-1119.

Subscription inquiries and change of address: Room 10-140, M.I.T., Cambridge, Mass. 02139 (617) 253-8292.

Prices:
Single current copies $4 U.S., $5 Canada, $7 foreign. Subscriptions, one year: $24 U.S., $34 Canada, $44 foreign. Back issues available. All prices U.S. funds.

Technology Review is a member of ABC

A New View


M. Goldman

In this issue, *Technology Review* welcomes a new columnist. Marshall I. Goldman is Class of 1919 Professor of Economics at Wellesley College, as well as associate director of the Russian Research Center at Harvard University. An economist by training, he has specialized in research on economic, energy, and environmental issues in the Soviet Union. His latest book is *The U.S.S.R. in Crisis: The Failure of an Economic Model*, published by W.W. Norton in 1983. Professor Goldman's articles have appeared in such diverse publications as *Harvard Business Review, Foreign Affairs*, the *New Yorker*, and the *Washington Post*. He will write for *Technology Review* on a quarterly basis, focusing on issues that involve economics and technology. His first column, part of an overall look at how regions can attract high-technology companies, appears on page 6.
—*Peter Gwynne*

Misleading Clues

Samuel Florman's criticism of those who point to lead as the "clue to the decline of Rome" (*"Why the Lead-Pipe Theory Is Dangerous to Our Thinking," August/September, page 10*) reminds me of a similar simpleminded "clue": airborne lead pollution in the United States. We are told that inner-city children become mentally-handicapped when they breath lead-loaded auto exhaust fumes. But recent declines in lead pollution have been accompanied by declines in school test scores. As Florman suggests, we should stop making inane *post hoc, ergo propter hoc* correlations.
John S. Kebabian
Becket, Mass.

Tracking Railroad Options

I am puzzled that Tom Shedd does not mention one innovative concept in railroading, and gives short shrift to another, in "The Little Engine That Does" (*February/March, page 60*). The first concept is the "roadrailer," a railroad car that can also be towed as a truck-trailer—a sort of intermodal container on wheels. The roadrailer is designed to accommodate the high-value, fast, short-train traffic referred to by Shedd and by John Meyer in "Keeping the Railroads on Track," (*February/March, page 64*). This equipment has been built and road-tested.

The other concept is the renewed attempt to design locomotives to burn mine-mouth coal. The potential here for reducing fuel costs and helping to achieve national energy independence is considerable. Shedd says only that the railroads do not want to go back to coaling towers, water tanks, massive maintenance shops, and frequent stops. Yet one engine being offered, the ACE-3000, is specifically designed to fit within diesel-style maintenance and support facilities and to run long distances. The idea of using coal-burning locomotives is strengthened by the launching of the S.S. *Energy Independence*, a new coal-burning collier serving New England ports. The shipping industry would have greeted such a ship with derision before the Arab oil embargo. At least six other coal-burning ships are also operating in the world today.
Charles Kluth
Baltimore, Md.

Mr. Shedd responds:
American Coal Enterprises' ACE-3000, like another design proposed by North American Locomotive Co., is essentially a dramatically updated version of the traditional reciprocating steam locomotive. The four-cylinder unit, designed to operated in a rail system along with diesel locomotives, would have a two-stage gas-producing combustion system. A microprocessor would control delivery of coal to the firebox and power to the drive wheels in response to the throttle settings. Coal would be supplied in 33-ton containers, so the ACE-3000 could run 500 miles on a container of coal and 1,000 miles before requiring additional water.

While the company maintains that the ACE-3000 could be serviced and maintained at existing diesel shops, additional facilities would be required to supply the coal and water, as well as to service and maintain the steam engine and its components. Although the locomotive would use available technology, details of how that technology would be applied in a rail-

road setting are far from clear. Much prototype testing would be required.

Thus, with the energy efficiency of the diesel continuing to improve, it is not surprising that railroads are lukewarm about proposals to resurrect the steam locomotive. However, several are looking carefully at the ACE proposal and we may see a prototype built soon.

Studying the Artificial World

According to "Classroom Technology" (*February/March, page 85*), Professor Morris Shamos of New York University recommends using technology to teach scientific principles to high-school students. I think Shamos' objectives are similar to those of the Engineering Concepts Curriculum Project, which produced a text called *The Man-Made World* in the 1960s.

After working on this project, I introduced the material to a public school in Fairfax County, Va., but thousands of other schools have been not reached. We may have been 15 years too early, but I hope Shamos, the National Science Teachers Association, and anyone else interested in science education will help find a way to get this idea moving.
John G. Johnson
Arlington, Va.

They Grow 'Em in the Midwest

Robert Cowen's "Avant Garde Science Journalism" (*January, page 6*) is a good example of the East Coast and West Coast snobbism that pervades the science-writing profession. In listing seven university science-writing programs, Cowen failed to mention the two programs that are the oldest and most successful at turning out distinguished science writers. They are the programs at the University of Wisconsin-Madison and the University of Missouri-Columbia.

I cannot speak for the Missouri program, but as a graduate and former head of Wisconsin's University-Industry Research (UIR) Science Writing Program, I would like to point out some facts that may have escaped Cowen's notice. The UIR program has been training science writers for nearly 20 years, having been started in 1965 by Dr. James Larsen with funds from the National Science Foundation. Now under the direction of Jean Lang, students not only write press releases and feature articles for the program's *Touchstone* magazine, but they also attend weekly seminars on science writing and edit one another's work.

Over 70 science writers have graduated from the UIR program, including Jane Brody and Bill Broad of the *New York Times*, Mike Woods at the *Toledo Blade*, Bruce Ingersoll of the *Chicago Sun-Times*, and Jim Napoli of the *Hartford Courant*. And then of course there is Tom Burroughs, now a senior editor at *Technology Review*, and Dennis Meredith, former managing editor of *Technology Review* and now head of Caltech's news bureau and a widely published free-lancer.

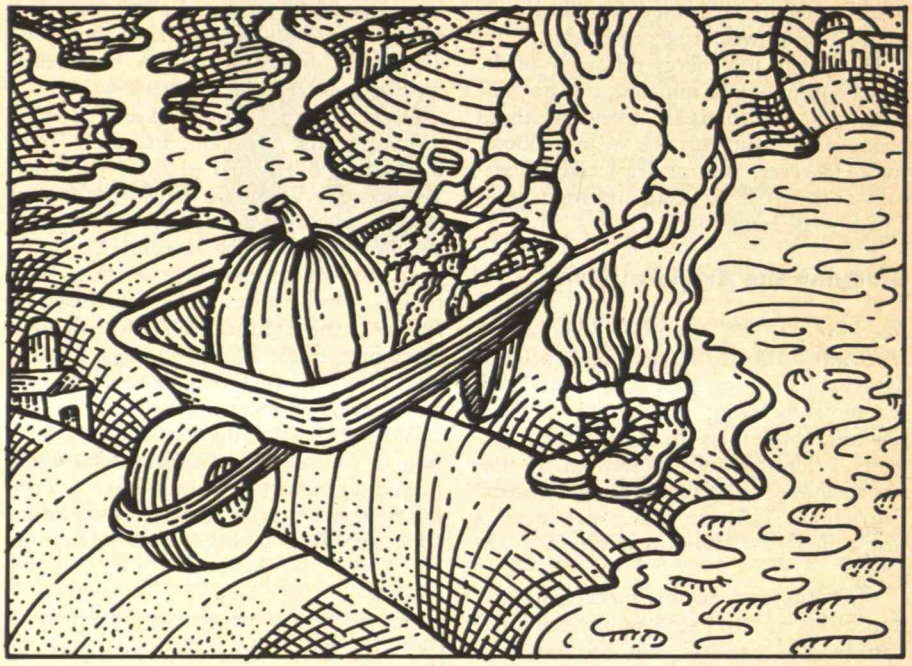
As Cowen says, the National Association of Science Writers may have once played an important role in science writing. However, today it spends most of its time debating whether members who work in public relations should be allowed to vote for officers.
Joseph Alper
Washington, D.C.

Theory of Knowledge

If we give up trying to define the meaning of thinking, as Marvin Minsky suggests in "Why People Think Computers Can't" (*November/December, page 64*), then artificial intelligence could mean anything at any time to anyone. Thus, even the attempt to discuss the subject reduces it to nonsense. This problem stems from the author's lack of recognition of the validity of concepts. Ayn Rand's *Introduction to Objectivist Epistemology* covers this issue well.
Herbert Heller
Pittsburgh, Pa. *Continued on page 18*

ROBERT C. COWEN

Bailing Out Chesapeake Bay



CHESAPEAKE Bay received special mention in this year's State of the Union address, some eight years after Congress directed the Environmental Protection Agency (EPA) to help avert an ecological disaster there. Speaking of the largest U.S. estuary and one of the world's most productive water bodies, President Reagan said, "We will begin the long, necessary effort to clean up a productive, recreational area and a special resource."

The rescue effort comes none too soon, for the bay is visibly suffering. Submerged vegetation and many animal species are declining. Commercial catches of crab and fish have dropped off. The extent of seasonal "anoxic," or oxygen-depleted, water has increased dramatically. Nevertheless, these alarming trends can probably be reversed as the EPA's Chesapeake Bay program moves from its research phase to action.

EPA's Greene Jones, chairman of the program's management committee, says he's optimistic about the possibility for recovery. The bay is not dead but it is deteriorating, he says, just as Lake Erie was deteriorating, partly from the effects of pollution. Citing the fact that pollution control saved Lake Erie, Jones says he doesn't think "there's any question that it [the quality of the bay] can be enhanced."

The more than eight-year delay between congressional authorization of the bay program on October 17, 1975, and President Reagan's call for action is not due to procrastination. Rather, investigators have taken that long to build a base of scientific knowledge for an effective recovery effort.

Case History

Chesapeake Bay is a vast and complex ecosystem. The bay proper covers more than 2,500 square miles, being roughly 200 miles long and ranging in width from about 4 miles near Annapolis to 30 miles at its widest near the mouth of the Potomac. The bay is shallow, averaging 28 feet in depth, and is sustained by a vast 64,000-square-mile drainage basin with over 150 rivers, creeks, and streams. Of these, 8 contribute 90 percent of the bay's freshwater input; the Susquehanna alone accounts for half of this replenishment. With that complexity, anyone can see that the quality of the bay depends on how land is used and managed throughout the entire drainage basin. That is why the EPA had to do more than a quick study of the bay itself to determine why it is suffering.

The EPA also has had to separate human-induced changes from natural effects. The bay is geologically very young, having formed a mere 15,000 years ago as melting Ice Age glaciers raised sea level. More recently, and without any human impact, the bay has undergone major changes owing to constant erosion along its edges and heavy silting from the land. Thus, the EPA has not only done extensive field work to determine the present condition of the bay, but the agency has also tried to understand how the bay has changed, especially during the past century.

The EPA now says that these efforts have produced the largest database ever compiled on a single estuary. Investigators have used this information to back up the impression of fishers, residents, and other bay users that the quality of the bay has been declining.

The EPA does not claim to have made a definitive assessment of the causes of the bay's problems. For example, in the report on the program's findings and recommendations, investigators note that "we have correlations, not proof. We also do not know with certainty to what extent levels of pollution must be reduced to achieve a quality of water that can support resource objectives. Mathematical models, which will someday enable us to arrive at these answers, have not yet been perfected."

Nevertheless, investigators believe they have sufficient evidence to pin down the major cause of bay decline—pollution by toxic chemicals and nutrients such as nitrogen and phosphorus. In attempting to assess the bay as an "organic whole," scientists discovered that circulation patterns trap pollutants within the bay instead of flushing them through to the sea. Sediment in the water also adsorbs pollutants and sinks to the bottom, where the materials enter the food chain through the action of bottom-feeding organisms.

This process of increasing contamination has gradually changed the bay's character. Robert J. Orth and Kenneth A. Moore of Virginia's Institute of Marine Science have found that all species of submerged vegetation had been significantly reduced during the past 15 to 20 years. The reseachers conclude that "this estuar-

ROBERT C. COWEN is science editor of the *Christian Science Monitor* and former president of the National Association of Science Writers.

ILLUSTRATION: ARMEN KOJOYIAN

ine system has been undergoing an environmental stress of major proportions."

According to Orth, nutrient pollution is probably the most important reason for the plants' decline in the northern part of the bay, where the problem is most severe. Algal blooms stimulated by excess nutrients block the light going to larger vegetation. Small plants and animals that grow on the seaweeds are also stimulated, forming dense mats.

The submerged plants are important because they provide a sheltered habitat for young crabs and fish. They also help clarify the water by trapping sediments, and they are a food source for some animals. Thus, a decline in the submerged vegetation has wide ecological effects.

The decline of dissolved oxygen also affects many animal species. Some variation in oxygen levels is natural, but the area now suffering from cyclical anoxia has grown far beyond what is natural. This lack of oxygen is also caused by nutrient pollution, which stimulates excessive growth of microscopic plants which, in turn, use up oxygen.

Corrective Measures

According to Jay L. Taft of the Harvard University Herbaria, who helped conduct this study, there is little doubt that farmland runoff is the main culprit in these problems, as the increase in nitrogen in the bay has paralleled farmers' increasing use of fertilizer. Thus, control of fertilizer runoff is the first major target for the action phase of the EPA program.

"Fertilizer runoff is the theme that runs through the whole thing," says Greene Jones. He thinks the problem can best be solved through education rather than regulation. Thus, agencies in Pennsylvania, Maryland, Virginia, and Delaware will promote the idea that it is in farmers' best interest to use minimum amounts of fertilizer, as well as encapsulated rather than soluble fertilizer products. Conservation tillage could also help, although that technique could require heavier use of pesticides.

Of course, other factors will also have to be better controlled to save the bay, including pollution by toxic chemicals and urbanization of watersheds. At the heart of the problem is population growth. About 12.7 million people live in the Chesapeake basin, and that number is expected to grow to 14.6 million by the year 2000. Jones hopes that public awareness of the bay's problems will encourage cooperation with EPA efforts to save the bay.

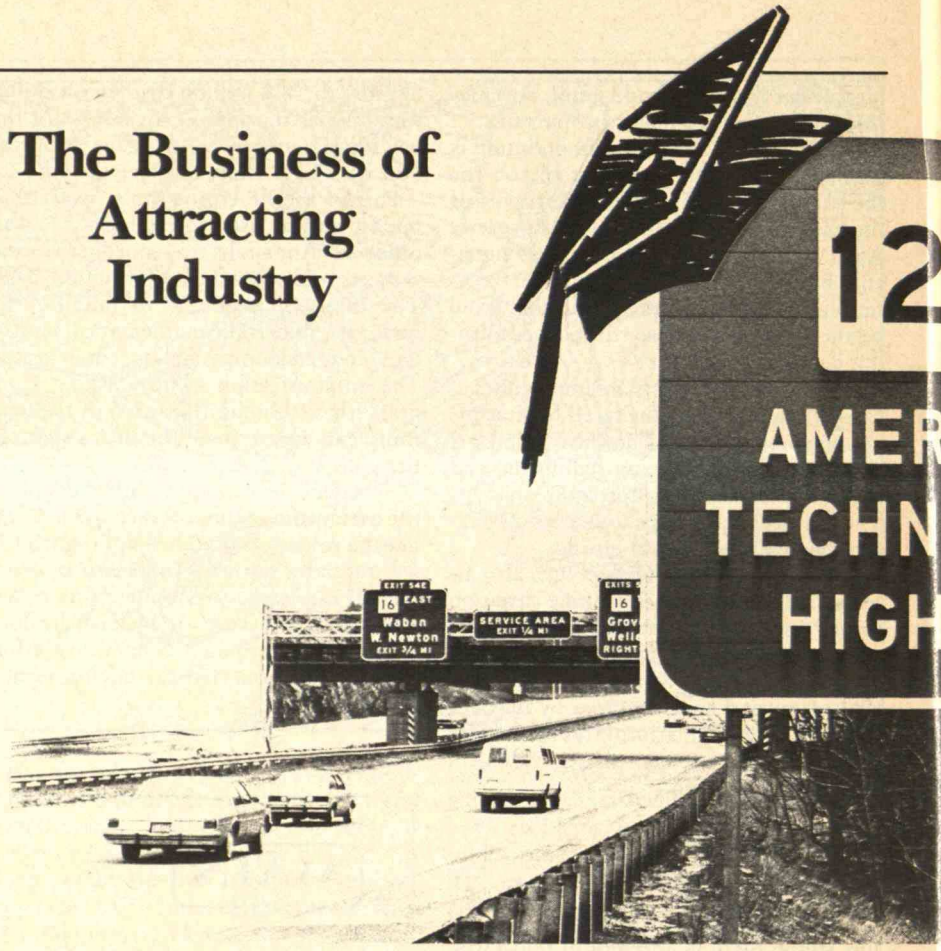
Part of the EPA program's fiscal 1984 budget will be used to establish a liaison office at Annapolis to coordinate state projects and act as an information base. The EPA will continue to monitor the main bay, undertake mathematical modeling, and encourage public cooperation. The administration is now asking Congress for $10 million for each of the next four years to carry out the EPA's share of the joint state-federal effort.

President Reagan has rightly recognized the extraordinary importance of the Chesapeake rescue effort. The bay is much too substantial a resource to lose to environmental carelessness. Moreover, its rescue would be a showcase for what can be done through a determined cooperative effort among state and federal environmental agencies.□

Building a Mecca for High Technology

by Marshall I. Goldman

The Business of Attracting Industry



WHILE the surprisingly robust recovery of the American economy has revived some of our smokestack industries, there is a growing sense throughout the country that the surest way to economic prosperity is the development of what is loosely described as high technology. Heralded as models of success in this endeavor are Massachusetts, with its belt of electronic and medical technology stretching between highways 128 and 495, and California, with its Silicon Valley. Both areas have flourished as entrepreneurial centers of high technology, manufacturing products such as computers, software, and electronic equipment.

The development of high technology in these regions has not only generated new industrial jobs. It has also stimulated the creation of jobs in such local business services as law, banking, advertising, transportation, consulting, and retailing. In fact, some studies show that two service jobs result whenever a new manufacturing job in high technology is created. And that ratio is probably even higher when a high-tech company's headquarters are near its manufacturing activities.

Small wonder that other states -- such as North Carolina, with its Research Triangle Park, and Texas, with its newly emerging microelectronics center in Austin -- are striving hard to emulate the example set by Massachusetts and California. Representatives from almost every state in the nation, as well as from most of the mature countries in Western Europe, have come to Boston and Santa Clara to see if the process can be duplicated. Many have focused their attention on Massachusetts, seeking the magic that will explain how a state with the highest unemployment rate of all the industrialized states in 1975 managed to emerge a mere six or seven years later with the lowest or near-lowest unemployment rate.

Now that Massachusetts is so prosperous and its manufacturing, construction, and service industries are so active, it seems only natural that the high-tech revolution should have begun here. But this is more of a rationalization than an explanation. It is also an example of how easily we accommodate ourselves to what exists. Certainly there were few people in the depressing days of 1975 who predicted that Massachusetts would arise from its economic misery.

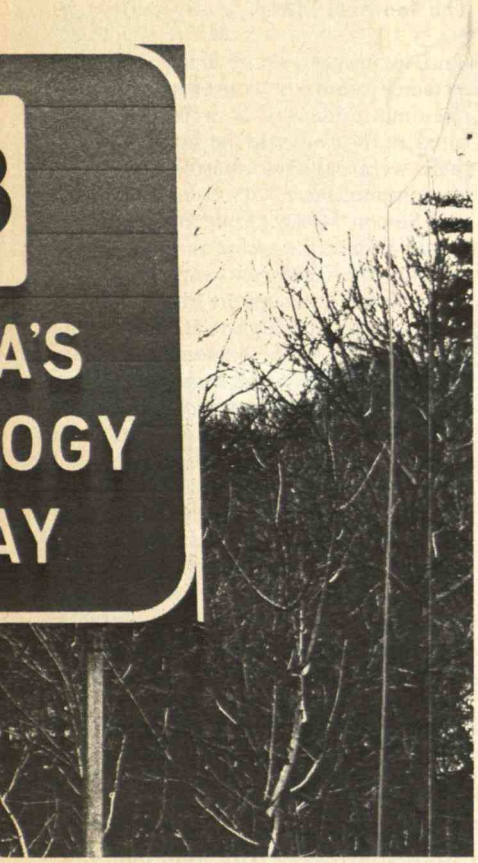
Taxachusetts

Most of the state's traditional textile and leather businesses had already gone down in bankruptcy or had moved to cheaper locations elsewhere in the United States, Asia, and the Southern Hemisphere. Nor were the new high-technology companies spared. Caught by a slash in military contracts brought on by the end of the Vietnam War and the accompanying antiwar and antitechnology atmosphere, many of the state's high-tech companies were forced to cut back sharply or even to close their doors. A large number depended too heavily on government contracts. But because of the recession, conditions in the civilian sector were not much better.

On top of everything else, more and more local corporate leaders were threatening to move out of Massachusetts, or at least to curb their expansion within the state. After all, the state was noted for its hostility to business from both government officials and university activists. This was typified by the state's high tax rates (it was known as "Taxachusetts"), expensive and unionized labor, and the conservativeness of its bankers. The state's remoteness from consumer markets and sources of raw materials were also considered disadvantageous. Nor did it help that after Hawaii and New York, Massachusetts had the nation's third-highest electricity rates. Few, if any, professional location companies even included Massachusetts as a possible site for plant construction or corporate headquarters.

The one thing Massachusetts did have was one of the largest concentrations of undergraduate and graduate students in the country. And that group included a disproportionate number of engineering students, particularly at M.I.T. For example, even though Massachusetts had only about 2.5 percent of the nation's pop-

PHOTO: MARJORIE LYON



ulation, in 1961 it graduated over 4 percent of the country's engineers obtaining a bachelor's degree, over 6 percent of the engineers obtaining a master's degree, and over 7 percent of the engineers receiving a doctoral degree. Many of these graduates found that Boston was a nice place to live, and they stayed on as researchers in the area's labs. According to a recent survey by the Massachusetts High Technology Council, 80 percent of the engineers now with Massachusetts companies received their last education in Massachusetts schools.

The Academic Bridge

For many years, it had been all but impossible for these young specialists to find private-sector jobs in the region. This situation seemed to change in 1957, when the Soviets announced they had orbited the world's first sputnik. As the United States embarked on a crash program to catch up, representatives from Washington scoured the country to find anyone

Continued on page 8

Environmental Laws: A Pink Herring

by Howard A. Stafford

In the last decade, industry representatives have often blamed environmental laws for the failure of businesses to locate or remain in a particular state. Some have even contended that the widely noted shifts from the "frostbelt" to the "sunbelt" are largely due to environmental regulations. But these observations are not substantiated by fact. Several recent studies indicate that environmental regulations are actually of little consequence in companies' decisions about location. A study that my colleagues and I conducted at the University of Cincinnati shows that such regulations are not usually included among the top ten variables that large corporations consider when deciding where to locate a new plant.

These findings do not mean that local governments can afford to be complacent about the impact of strong environmental laws on the cost of doing business. Many companies are indeed concerned about the increased costs and long delays involved in acquiring the various permits required by environmental regulations. There's no question that many federal and state agencies charged with enforcing environmental regulations could do more to assist industry in the often arduous task of acquiring these permits.

The Top Ten

At the University of Cincinnati, we surveyed 162 large U.S. corporations through questionnaires and interviews. Of these firms, 90 percent were among the 500 largest in the country. Half were in industries that have significant pollution concerns: chemicals, steel, engine manufacturing, and smelting operations. The other half represent the traditionally "clean" industries, including electronics, food, metal fabricating, and machine tools.

For these 162 companies, the top ten locational factors are: 1) availability and cost of labor; 2) nearness to markets; 3) availability and cost of transportation; 4) nearness to materials suppliers; 5) quality and availability of utilities 6) quality of life; 7) business climate; 8) characteristics of available land parcels; 9) other characteristics of specific communities, such as quality of housing and shopping; and 10) taxes. Although environmental regulation did not make the "top ten" list, it did rank eleventh in this survey. Variables that ranked even lower included promotional efforts by local economic development organizations, the preference of individual executives, and inertia.

These research results are corroborated by an independent study recently completed for the Conservation Foundation, a nonprofit organization concerned with environmental preservation. In this 1983 study, Christopher J. Duerksen concludes that the "right to pollute is not an important locational determinant. No evidence of a migration of industry from one state to another in search of 'pollution havens' was unearthed." The study also concludes that environmental regulations are not the primary cause of long delays in industrial construction projects.

Even a "subsample" of companies that face extensive pollution-control requirements did not consider environmental regulation a top priority. For this subgroup of the 162 companies surveyed by my University of Cincinnati group, the top ten location variables are 1) markets; 2) labor; 3) access to materials; 4) transportation; 5) environmental regulations; 6) utilities; 7) site characteristics; 8) the locations of a firm's other operations; 9) quality of life; and 10) business climate. Since environmental regulation did not even appear on such lists a decade ago, its current inclusion shows that it is now of some importance for some industries. But even for these traditional "smokestack" industries, it ranked only fifth—far outweighed by other variables. In the subsample of traditionally "clean" industries, environmental regulations ranked eighteenth out of twenty.

In an interview conducted for this study, the vice-president of a steel company displayed a mountain of environmental-impact documents amassed for the proposed siting of a new steel plant. But this executive also noted that the project was aborted—not because of environmental difficulties, but rather because of the decreasing demand for steel and the difficulties of dealing with worldwide competition. In fact, the executive later

Continued on page 10

ILLUSTRATIONS: KATHERINE MAHONEY

One-time laboratory jocks found themselves running small for-profit enterprises.

A Mecca for High Technology

(Continued from page 7)

with an idea or a product that would add to the nation's space and military arsenal.

Contracts were freely offered and one-time laboratory jocks suddenly found themselves running small for-profit enterprises almost entirely dependent on government support. In Massachusetts, as in Silicon Valley, this process was nurtured by sympathetic university scholars who urged their students to seek their fortune in the private sector. That was how Hewlett-Packard got its start in California. Digital Equipment Corp. was born the same way in Massachusetts. In fact, a study by Edward Roberts of M.I.T.'s Sloan School of Management shows that of 216 high-tech companies in the Boston area, 156 were created in M.I.T. departments and laboratories. On both coasts, universities also provided facilities crucial to the entrepreneurial boom of the 1950s and 1960s. Stanford, for instance, showed incredible foresight in constructing an industrial office park in 1951. And M.I.T. was fortunate enough to be surrounded until the late 1960s by cheap warehouse space that was ideal for new manufacturing factories.

Once in operation, these entrepreneurial efforts tended to stimulate the growth of others. Some new entrepreneurs came into the area, and others left existing firms to set out for themselves in the hope that they too would find their fortune.

But why didn't the same sequence of events occur in Philadelphia, with its University of Pennsylvania, Temple University, and Drexel Institute? After all, the world's first computer was developed at Penn's Moore School of Engineering. Yet the high-tech boom in Massachusetts soon eclipsed this rather modest development.

Some have argued that Philadelphia failed to join the high-tech revolution because it lacked venture capitalists and was not as pleasant a place to live. Also, the city's leading educational institutions may not have had the kind of mentor-pupil relationship that faculty and students at M.I.T. and Stanford enjoyed. For whatever reason, Philadelphia had trouble holding onto the engineers it trained.

High Tech Goes Civilian

At the beginning of the high-tech boom in Massachusetts, many entrepreneurs found themselves almost entirely dependent on government contracts. In 1965, 60 percent of the state's high-technology business stemmed from the Department of Defense and the National Aeronautics and Space Administration. But by the time the Vietnam War drew to a close and military spending was cut, the new technology these companies had developed had begun to sell in the nonmilitary arena. By 1980, most of the high-technology firms had found their footing in civilian markets and the government's share of such business had dropped to 25 percent.

Another factor in the state's resurgence was the government's change in attitude toward corporate taxation. Starting with the administration of Governor Michael Dukakis and continuing with that of Governor Edward King, the state made a conscious effort to keep property and personal income taxes down to promote the development of high technology.

As a result, whereas once the region had been sought for its lifestyle advantages, it now became *the* location for high-technology ideas, contracts, and financing. More important, the goods produced were expensive relative to their weight and high in value-added. That is, most of the products' value stemmed from the costly labor involved in making them rather than the raw materials. Thus, access to a good airport, for transporting compact and valuable computers and components, became more vital than access to raw materials and the nation's geographical center.

The Snowball Effect

Once in business, a core of industrial firms attracted similarly constituted firms. A one-time resident of New Jersey who located in Boston said he concluded that there were only two feasible choices for his computer-accessory company, Boston and Silicon Valley. Only in those areas would he find the technical staff to work for him, the vendors to supply him, and the customers to support him.

Of course, the high-tech industry will not limit itself to the Boston and Stanford areas forever. Likewise, some regions must accept the fact that high technology is not the answer to their economic woes. States such as Pennsylvania and Michigan should use the new technology instead to build up their industries and improve the quality and price of their products, whether they be automobiles or specialty steel.

But those areas that hope to nurture the development of high technology should realize that it cannot occur without the presence of high-quality universities and good research-oriented engineering schools. The living environment must be inviting, and venture capital must be available. By building on their academic strength, North Carolina and Texas seem to have learned those lessons well. Austin has a rapidly growing and independently wealthy state university. Thus, the city has managed to lure the Microelectronics and Computer Technology Corp. (MCC), a research and development consortium of 12 companies, to its inland location, knowing full well that the sponsoring companies are likely to open up branches nearby. And North Carolina has done a remarkable job of packaging the Research Triangle Park, with nearby University of North Carolina at Chapel Hill and Duke University, as a prime location for high-technology firms. However, most of the firms located there are branches of larger corporations headquartered elsewhere; the entrepreneurial thrust that put Boston and Silicon Valley on the map has not yet surfaced.

Despite these differences, North Carolina and Texas seem well on their way to recreating their own Route 128s. Only after other areas have built up their scientific educational establishments will they be able to do the same. □

MARSHALL I. GOLDMAN is professor of economics at Wellesley College.

Route 128: The Entrepreneurs' Story

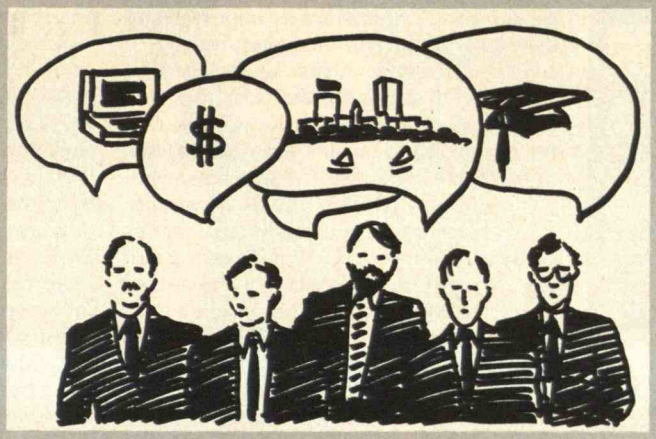
BY MARK TEMPLER

As the United States emerges from its worst recession since the Great Depression, politicians and economic experts have a new buzzword on their lips: "high-tech entrepreneurship." Community leaders across the country gaze with envious eyes at places like Silicon Valley and Route 128 near Boston. But communities that hope to emulate those areas must understand the roots of their success. In doing research for my master's thesis, I have uncovered some interesting insights into the development of high technology in Massachusetts.

My research is based on questionnaires sent to 117 of Massachusetts' high-technology firms and personal interviews with top executives in 35 of them. Altogether the 117 firms employ about 20,000 people in the state and have annual sales of about $1.4 billion. Their products include computer-aided design and manufacturing systems (CAD/CAM), microcomputer software, industrial electronic equipment, and biotechnology.

Almost all the executives of these companies highlighted the role of universities in Route 128's development. They identified two ways that universities have promoted high-technology growth: by supplying skilled engineering professionals to existing firms, and by generating, through their research, technological advances and spin-off firms.

Some executives downplayed the research capabilities of universities, emphasizing their role as labor suppliers. For instance, about 30 percent of the entrepreneurs felt that a good deal of university research was either too theoretical or obsolete for their needs. "Being bright



isn't necessarily the most important thing in business," observed one entrepreneur who has founded three successful electronic-equipment firms. "Being able to make things work is important." He has hired graduates of M.I.T., Northeastern University, and Boston College with a great deal of success. Other entrepreneurs were particularly positive about Northeastern's cooperative work-study program, which they described as "responsive," "well organized," and "cooperative."

The Driving Force

However, more than two-thirds of the entrepreneurs saw universities not only as labor suppliers but also as vibrant sources of new ideas and firms. These people saw M.I.T. in particular as having been a driving force behind the development of Route 128. Among those interviewed was an M.I.T. alumnus who started a computer software firm with five other alumni right after they graduated; they used their theses for product development. "We chose to be near M.I.T. because it helped us," notes the alumnus. "It is not a matter of proximity. It is a matter of never having left."

Another software company uses M.I.T. students for almost all its product development, starting them off in part-time jobs during the school year and gradually moving them into permanent positions. One M.I.T.-trained entrepreneur, who has helped found three computer/artificial-intelligence equipment firms, said that only institutions like M.I.T., Stanford, and Caltech are able to produce the kind of top-notch personnel he wants to hire.

The entrepreneurs suggested a number of ways for other universities to promote high technology in their area. For instance, they stressed the need for a positive university attitude toward industry. Many praised M.I.T. and Northeastern for their flexibility in allowing both faculty and students to consult with and join in R&D projects. Most called for greater industry access to university equipment and research, and increased industry support for university R&D. Many entrepreneurs felt that university and industry leaders should meet regularly to discuss topics of mutual interest, perhaps through an advisory panel.

These executives also supported "entrepreneurship" courses offered by various local universities, and they favored making continuing education more available to local engineers. A number of entrepreneurs liked the idea of establishing a university-run database that would list student (and faculty) thesis projects and employment interests, and cross-reference these to industry research interests and employment needs. Such a database could be used as an idea-matching dating service to hook up students and firms to solve company problems.

A Pool of Talent

According to the entrepreneurs, the industrial agglomeration around Route 128 has helped Massachusetts retain a solid pool of skilled technical professionals. Many of these people jump from one company to another, then into consulting, and finally into a business of their own. One manufacturer of microcomputer peripherals summed it up nicely: "In Massachusetts, skilled technical people are like water." The entrepreneurs identified several reasons why engineers like Massachusetts: it has a good intellectual environment, cultural events, city night life, skiing and sailing, decent public education, Cape Cod, ample job opportunities, and many nice camping areas.

The entrepreneurs agreed that venture capital is readily available in Massachusetts for firms with good ideas and a strong management team. But many faulted the Boston investment community for its "timidity" and "inability to understand technology." The entrepreneurs were unanimous in their support of the 1978 and 1981 changes that reduced the maximum federal tax on capital gains from 50

Continued on page 74

Environmental agencies need not dilute their regulations to be gracious to industry.

Environmental Laws: Low on the List

(Continued from page 7)

noted that "environmental regulations are only of mid-level importance in location decisions—about as important as taxes."

Death and Taxes

This association between environmental regulations and taxes is instructive. The two factors that most directly reflect government influence—taxes and environmental regulation—also rank low on executives' lists, at least in our study. Yet both continue to receive a great deal of notoriety—perhaps because they are among the few factors from which manufacturers can hope to get relief. It does little good to complain publicly about market changes or the inaccessibility of labor. But tax burdens and difficult environmental laws may be changed through the political process if enough pressure is applied.

Ironically, manufacturers rarely choose areas with the lowest tax rates. More often, they act like homebuyers who choose to reside in nice areas despite high taxes—and perhaps because of some of the services that those high taxes support. The evidence suggests that taxes, like environmental regulations and the time required to obtain operating permits, are used to assess how welcome business is in a particular area, rather than as important locational variables in their own right.

There is some evidence to suggest that some manufacturers prefer localities that are perceived as "pro-business" *and* that have relatively clean air. Areas considered particularly attractive for this reason include the Southeastern and Southwestern states, rural areas, and small cities. In this context, California and the Northeastern and North Central states are considered less attractive, because they do not meet air-quality standards and have a larger proportion of industrialized cities. These areas also have regulatory processes generally perceived to be cumbersome.

Because they have air-pollution problems *and* stringent environmental regulations, states such as Massachusetts and California would seem to be doubly cursed. But since many other factors influence location decisions, this is not necessarily the case. California, for example, led the nation in industrial growth during the 1970s, even while gaining a reputation as the most environmentally difficult state. The astounding success of Silicon Valley has contributed a great deal to this growth, but it is not the sole source. For many firms in more traditional industries, proximity to California's huge markets for manufactured goods more than offsets any environmental obstacles.

For example, although a senior vice-president of a major chemical company told a chemical-industry audience that "we probably will not build in California or any other state with a permit procedure that's as cumbersome," even the chemical industry grew more rapidly in California than in other parts of the United States during the 1970s. Likewise, the movement of many manufacturers to Southern states must be interpreted with care, since these areas are favored for reasons such as the availability of cheap labor and growing consumer markets.

Needed: A More Helpful Bureaucracy

While there is little evidence that the current regulatory system should be jettisoned, complacency is not in order. Environmental regulations are not benign, if only because they do increase the expense of doing business. What, for instance, are the true costs of production delays? How many projects have been stillborn because entrepreneurs considered an area's regulations too formidable?

We don't know what the net effect of environmental regulations is on locational decisions. But we do know from our survey that company executives are more concerned about the uncertainties and delays in acquiring the necessary permits than they are about the actual costs of providing mandated pollution controls. While only 44 percent of the respondents indicated that variations in the cost of pollution-control equipment are at all important, 76 percent said that uncertainty and delays might influence location decisions to some degree. This finding points to the need for some reform of the regulatory system—particularly in the way government bureaucracies treat industry.

A cooperative, rather than adversarial, relationship between those regulating and those regulated would be most beneficial. An area need not dilute its environmental regulations to be gracious in assisting industry in the difficult task of siting a new plant. Furthermore, contrary to their instincts, many industrialists might find themselves better off if the government agencies charged with environmental protection had more funding and personnel. Additional staff members could not only facilitate the interpretation of local regulations and help companies plan various construction projects; they might also help ensure that permits are approved in a more timely fashion.

The many industry executives who genuinely wish to help protect the environment are proof that it is not necessary to throw the baby out with the bath water. Indeed, executives are often quite positive about pollution control, not only because they are private citizens but also because an area's quality of life is an increasingly important locational attribute. Enforcement of pollution controls is good business, since heavily polluted areas are not usually viewed as attractive places to build new plants. While it is essential that the United States have both a cleaner natural environment and a healthy economy, it is clear that in the long run, these are complementary rather than opposing goals. □

Howard A. Stafford is professor of geography at the University of Cincinnati, Cincinnati, Ohio.

Show her she's the reason getting there was half the fun.

De Beers

A quality diamond of a carat or more.

Quality. It's as important in diamonds as in anything else you own. It's especially important in a diamond of a carat or more.

Extraordinary. One of nature's most perfect gifts. It's spectacular. Impressive. And rare. Crafted by a master cutter, it has exceptional clarity and color.

Your jeweler is the expert where diamonds are concerned. He can show you diamonds of a carat or more of such exceptional quality as to please even the most discriminating tastes.

Since this isn't the kind of purchase you make every day, we've prepared an informative brochure to help you make the right decision. Give her the ultimate. A quality diamond of a carat or more.

A diamond is forever.

The ring shown features a quality diamond of 2 carats.
For your copy of our brochure, send $2.00 to Diamond Information Center, Dept. C, 1345 Avenue of the Americas, NY, NY 10105.

The Mercedes-Benz 300D Sedan, 300TD Station Wagon and 300CD Coupe: with their high-output Turbodiesel performance, they are

The Mercedes-Benz Turbodiesels: the most powerful line of diesels sold in America.

THE MERCEDES-BENZ 300D Sedan, 300TD Station Wagon and 300CD Coupe represent three variations on a radical theme: the idea that dramatic over-the-road performance can be blended with diesel efficiency and stamina.

The idea works. These Mercedes-Benz Turbodiesels *move*. With accelerative energy and cruising ease worthy of gasoline-powered cars. With power enough to flatten hills and make quick work of sudden passing maneuvers.

A TURBODIESEL IS STILL A DIESEL

Yet consider the bottom line. The Turbodiesel you will be living with and maintaining and paying the bills for, year in and year out, is a true-blue diesel. No complex electrical system. No conventional tuneups. A durability factor that has become part of automotive folklore. And EPA estimates of 27 est. mpg and 33 highway.*

The key to the Mercedes-Benz Turbodiesels' performance is less the *turbo* than the *diesel*–its three-liter, five-cylinder engine.

It is unique, a high-torque powerhouse so advanced that it even oil-cools its own pistons as they move.

Turbocharging any engine boosts its power. Turbocharging this engine boosts its power by 45 percent.

Many makers have aped the Turbodiesel idea since Mercedes-Benz pioneered it in production automobiles in 1978. Scant surprise that no maker has yet aped the Mercedes-Benz Turbodiesels' performance.

SEDAN, STATION WAGON AND COUPE

The Turbodiesels rank not only as the most powerful but also the most *varied* line of diesels sold in America today.

The four-door 300D Sedan accommodates five persons and a gaping 12-cu. ft. trunk within a wheelbase of just 110 inches, helping lend near sports-sedan agility to this family-sized automobile.

"The 300D's success in striking a balance between ride comfort and handling response," reports one automotive journal, "is equalled by less than a handful of other cars in the world."

The 300TD Station Wagon interlaces the driving pleasures of a Mercedes-Benz with the workhorse utility of a five-door carryall. Total cargo capacity well exceeds 100 cu. ft. A hydropneumatic *leveling* system is integrated with the rear suspension, to help keep the vehicle riding on an even keel–even under heavy loads.

EXOTIC, YET PRACTICAL

The 300CD Coupe is the world's only limited-production two-plus-two diesel touring machine. It sits on a taut 106.7-inch wheelbase–one secret of its quick-witted agility. Its graceful coupe bodywork, sans central door pillars, is formed in a process involving intensive handworkmanship. The 300CD is that rarity of rarities, an automobile both highly exotic *and* relentlessly practical.

Sedan or Station Wagon or

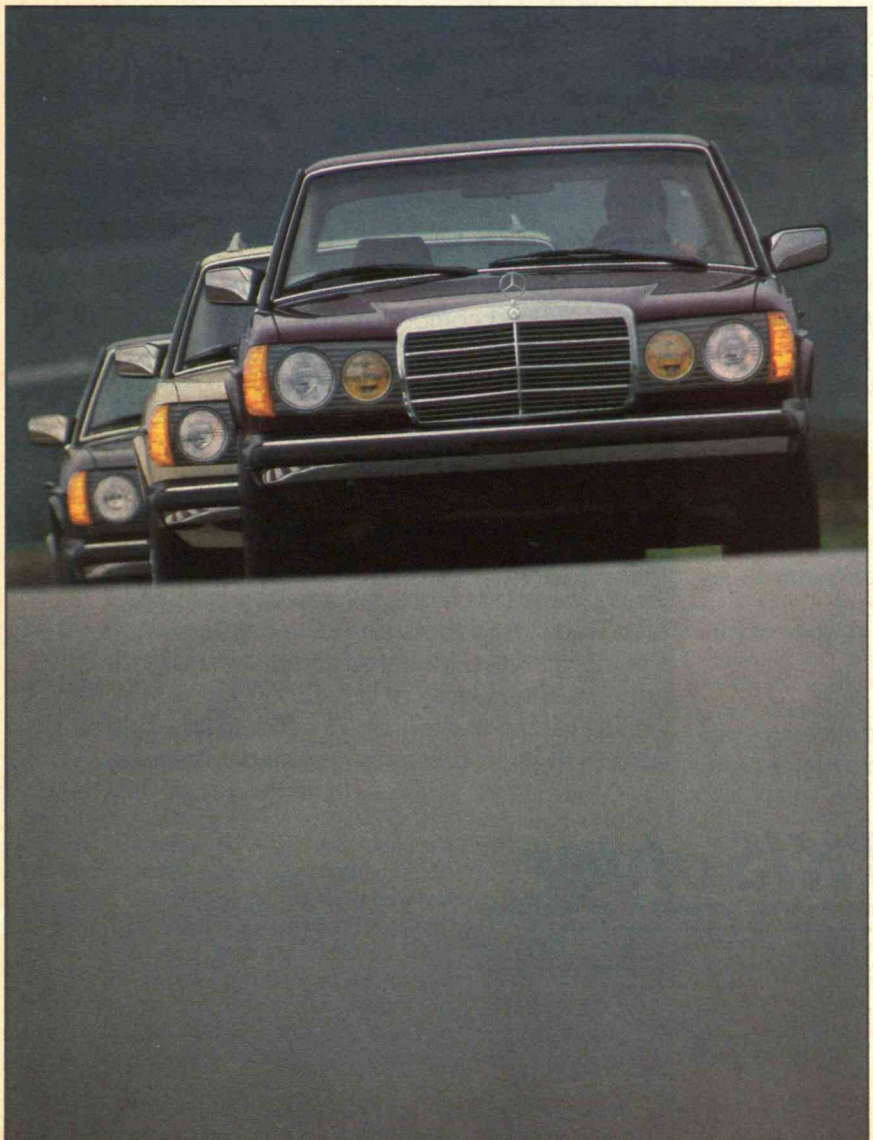
*Use EPA est. mileage for comparison. Your actual mileage may vary depending on speed, trip length and weather. Actual highway mileage will probably be less. California estimates may vary.

diesels apart. With their handling agility and riding comfort and obsessively fine workmanship and finish, they are automobiles apart.

Coupe, Mercedes-Benz Turbodiesel power is harmonized with high standards of performance in every sense of the word.

From suspension to steering to brakes, every Turbodiesel is engineered to be a precision driving instrument. "There's a cornucopia of driving delights at your disposal," concludes *Car and Driver*–suggesting that in driving precision there is driving pleasure.

From biomechanically correct seats, to a superb electronic climate control system, to the dulling of the outside wind noise to an almost inaudible murmur, remarkable comfort prevails. Distracting gadgetry is absent; virtually every *useful* driving amenity is standard, including an uncannily precise cruise-control unit. You pay not one cent extra, even for a sliding steel sunroof.



These are automobiles crafted not only with driving pleasure but mechanical longevity in mind. Thus, more than 30 pounds of undercoating are lavished on the underside of every Turbodiesel. Every body is a rigid steel shell welded at more than 4,000 strategic points. That glossy finish derives from a painstaking *nine-step* priming, painting and finishing process.

Safety precautions are remarkably comprehensive–both in helping avoid trouble, and in protecting the occupants should trouble occur.

MORE THAN POWER

Ultimately, the Turbodiesels' appeal extends beyond their performance and driving pleasure. There is no more powerful line of diesels in America–and there may be no more versatile, more competent, more timely line of automobiles. In America, or the world.

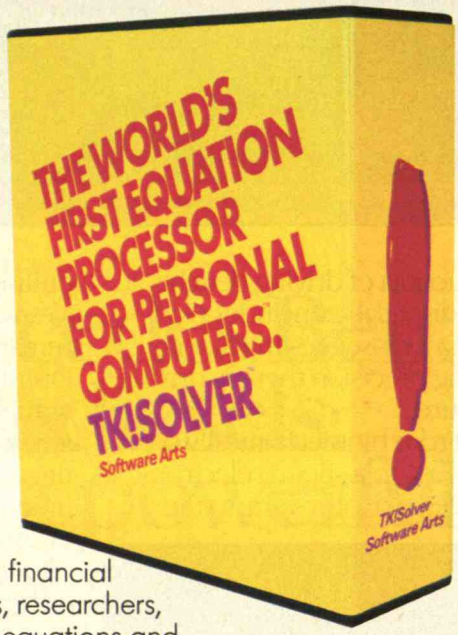
Engineered like no other car in the world

EQUATIONS PROCESSED

NO PENCIL. NO PAPER. NO MANUAL LABOR.

The TK!Solver® program will take on your toughest problems—linear, quadratic, simultaneous equations, whatever. Then stand back. Because TK!Solver turns your personal computer into a simple, yet powerful, desktop equation processor.

Whether your problem is a simple formula or a model consisting of many equations, TK!Solver can help improve your productivity. Once the equations are written, enter the known values, press the ! key, and TK!Solver gives you the answer.



Engineers, scientists, architects, financial analysts and planners, educators, researchers, and other professionals who use equations and mathematical models can work more creatively with TK!Solver.

TK!SOLVER GIVES YOU:

BACKSOLVING

If the programs you use now require you to rewrite the same equation to solve for different unknowns, TK!Solver can dramatically improve your productivity. Enter your problem once and then solve for the unknowns no matter where they are in your equation.

ITERATIVE SOLVING

If TK!Solver can't solve an equation directly, take an educated guess at the answer. Type the ! key and the TK!Solver program starts with your guess and performs repeated approximations to converge on the answer.

LIST SOLVING

Given a list of input values, TK!Solver automatically calculates the equation for every value in your list. For example, if you want to know how different interest rates will affect monthly loan payments, enter a list of interest rates and let TK!Solver calculate the payment amount for each value.

UNIT CONVERSIONS

Any type of unit conversion—Fahrenheit to Celsius, meters to feet, dollars to deutschemarks, newtons to dynes—can be made without altering your equations. Just define the numerical relationship between two units of measurement and the TK!Solver program automatically converts the variable value to the unit you specify.

TABLES AND PLOTS

Quickly generate tables and plots of your results on your screen or printer.

AVAILABLE NOW

You can run the TK!Solver program on the IBM® PC and XT and compatible machines, the Digital Professional™ 350, the Digital Rainbow™ 100, the Wang Professional Computer, Apple®//e, and on the following personal computers using MS™-DOS: TI Professional Computer, Grid™ Computer, Canon AS-100, Eagle® 1600, Toshiba T300, and the Zenith Z-100™.

SEE IT TODAY

There's more. Lots more. But you'll have to see it to believe it. And that's easy. Bring your own equations into your nearest computer retailer or call Software Arts directly at 617-431-6600 and ask to see the TK!Solver program in action. The world's first equation processor for personal computers.

TK!Solver®

By Software Arts,™ creators of VisiCalc®

27 Mica Lane, Wellesley, Massachusetts 02181 617-237-4000

Math Education, Scientism, and a New Economic Order

Math for the Masses

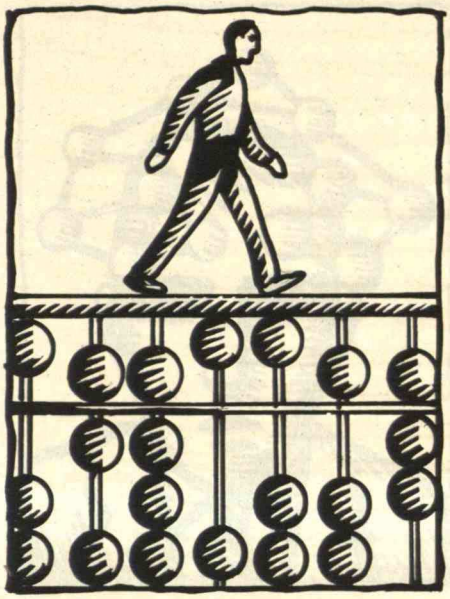
Numbers: Their History and Meaning
by Graham Flegg
Schocken Books, 295 pp.

Reviewed by Joan Baum

As Graham Flegg concedes in *Numbers: Their History and Meaning*, most people find mathematics a difficult subject. Thus, Flegg has written a history of mathematics that differs from other histories in its practical purpose: he wants to change the present by way of the past. A founding member of the Open University and past president of the British Society for the History of Mathematics, Flegg maintains that awareness of how other societies have thought about numbers can ease people's suspicion and ignorance of mathematics. Teachers who learn about ways of computing that were successful in the past will also be better able to individualize instruction and humanize mathematics.

Flegg holds that most people know nothing about the wonderful history of number as word, symbol, and idea. Even mathematicians who do don't seem to use that information in their teaching. The "public at large" is numerically illiterate—memorizing tables but not understanding concepts or relationships, doing calculations but unaware of or unwilling to try other methods, getting answers but not appreciating the play that can be at the heart of mathematical processes. Indeed, most schools present the theory and history of number only after traditional algebra, geometry, and calculus courses. And schools often keep algebra separate from arithmetic and neglect hands-on geometry for abstraction. In other words, the typical mathematics curriculum does not promote coherence and continuity.

Flegg urges parents and teachers to reconsider what they teach about number and how. He suggests that students study number from real-life problems and observations, and that teachers stress ways of checking calculations instead of simply displaying tables to be memorized. Teachers can use tricks to help students learn abstract principles, and can explain many concepts without resorting to technical terminology. Flegg also encourages teachers to emphasize number systems other than base ten, since binary numbers are important in data communications and computers, and other bases are required



in astronomy, geography, and navigation.

The elementary-school years are crucial for letting children create and experiment. Flegg recommends that teachers encourage students to use hands, feet, knots, and primitive counting boards, and to communicate in words what they are doing. Even so-called primitive techniques such as finger counting, still used in developing countries as a mark of native culture, can be used to promote numeracy. By becoming familiar with the trial and error, intuition, and curiosity that people have used to discover mathematical laws, students can better understand the link between numbers and what they symbolize.

Flegg shows how in earlier times, before counting systems became fixed, the words for numbers bore some relation to the objects being counted. For example, in English the words "yoke," "pair," "brace," and "duet" are still used to mean two of certain items. And terms such as "flock," "herd," "litter," and "shoal" hark back to a species-specific sense of many.

Flegg implies that most other histories of mathematics are not geared to the general reader. Even so, Flegg himself includes numerous algorithms, tables, and examples that may intimidate people who are not mathematicians. For example, he refers to the "beautiful proof" of *reductio ad absurdum*—a way to prove a contradiction that nonspecialists often find difficult to grasp. In fact, gaining a sense of the beauty of mathematics requires directed, continuous study, since its methodology differs from the way mathematical reasoning is used in the sciences. And Flegg may not encourage the fearful when he presents his thesis in prison metaphors: "There is no way in which we can escape from numbers," he begins, concluding that history "frees" us from the "straitjacket" of contemporary trends in math education.

The problem is to convince teachers to learn and transfer enthusiastically these techniques to the classroom. Elementary-school teachers, in particular, are neither mathematicians nor historians. Flegg is on the right track in trying to bring the history of mathematics into the classroom, but unless those on whom teaching depends are better trained, the plan will derail. Still, perhaps the widespread recognition that our country must better train both teachers and students will encourage the use of Flegg's ideas. □

Joan Baum teaches English at York College of the City University of New York and is a long-time student of mathematics.

Deifying Scientists

Future Life
by Michel Salomon
Macmillan, 384 pp.

Reviewed by Jonathan Beckwith

From popular science magazines such as *Omni* and *Science Digest* to science sections in daily newspapers, U.S. society is increasingly exposed to the achievements of modern science, medicine, and technology. This expanded awareness is extremely important if an educated public is to participate in decisions on how best to use these advances. However, science reporters often do readers a serious disservice by taking an uncritical attitude toward their subjects. Contrast the public's reverent attitude toward the pronouncements of scientists with that accorded the utterances of politicians.

Unfortunately, both scientists and the public often carry this attitude one step further by succumbing to "scientism": the belief that the methods of the natural sciences are essential to all other disciplines, including philosophy and the social sciences. For example, the late biologist Jacques Monod suggested that a new value system based on scientific "objectivity" re-

ILLUSTRATIONS: ANTHONY RUSSO

place religious values and social theories. And pop science magazines tout fields such as sociobiology that claim to explain all social arrangements in terms of evolutionary imperatives. The implication of such ideas is that science and technology can provide solutions to most social problems.

Thus, many people think that science is ushering in a new wonder era, where not only will we be able to solve the world's health and hunger problems, but we will also be able to understand and control human behavior. However, although contemporary medical advances are clearly being used to improve many people's health, some of the world's most serious health issues have their roots in social, not biological, conditions. For instance, huge quantities of "surplus" food rot in U.S. warehouses while poor people here and abroad starve to death. The world is capable of feeding its population; the challenge is to organize economies and systems of food distribution so that everyone is fed. And using genetic engineering to create nitrogen-fixing plants—a questionable prospect—will not solve such problems. In fact, the history of the Green Revolution, in which higher-yielding strains of grain were developed that required the use of pesticides and fertilizers, shows how a supposedly beneficial agricultural technology can have negative results.

Scientism is dangerous because it distracts society's attention from the underlying causes of its problems and discourages ordinary people from actively trying to solve them. If people think social issues have scientific solutions, then they may not feel they have enough knowledge to deal with them.

The spirit of scientism pervades *Future Life* by French doctor Michel Salomon. Salomon asks 18 prominent scientists to predict the effects of developments in biology and medicine during the next several decades. He poses questions such as, "Is it possible to live to 120 years?" "Will man be able to exercise biological control over his own body by means of miniaturized appliances containing microprocessors?" And, "To make people more tolerant of one another, won't we have to resort to drugs?" Thus, Salomon establishes a framework wherein problems such as aggression are considered issues to be resolved scientifically—his "future life" is dominated by computers, prosthetic devices, and mind-altering drugs.

Most of Salomon's respondents accept

be applied to human relations. Neurologist José Delgado says that "it is vital to establish programs of education with a biological basis." Biochemist Roy Vagelos views control of aggression, learning, mental illness, and homosexuality largely in biochemical terms. Immunologist Robert Good believes that the "scientific revolution in medicine will have more influence for good than any of the other revolutions." Of course, not even those who accept Salomon's assumptions respond uniformly. For example, while ethologist Konrad Lorenz argues that human behavior, including a sense of "goodness" and "beauty," is biologically based, he strongly opposes attempts to alter behavior by social or genetic engineering, as that would mean interfering with evolution.

A few scientists do resist Salomon's dogged attempts to get them to view social evolution simply in biological terms. For example, the late microbiologist René DuBos doubted "whether the scientific method is of much use in helping to make judgments about social problems." He preferred to focus on the environmental sources of disease, including cancer. Similarly, biochemist Henri Laborit points to the family and society, as well as individual frustration, as sources of ill health. However, he foresees a time when control of technological evolution will fall into the hands of people who want to decentralize political power!

Because Salomon limits his questions to such a narrow perspective, he virtually ignores the world's most serious health problem. Hundreds of millions of people suffer, and many millions die each year, from a variety of parasite diseases such as malaria, schistosomiasis, and filarial illnesses. Yet Salomon prefers to deal with problems of the wealthier classes of Western industrialized societies—not surprising, given the cast of characters. All the scientists interviewed are white, Western males, and most are middle-aged and older. If women and Third World people had been asked to address the problems that concern them, they undoubtedly would have given a much different view of scientific progress, focusing instead on fields such as reproductive technologies. Instead of pointing to genetically engineered plants to solve agricultural problems, they might have highlighted integrated pest management and strategies for food distribution.

Salomon further contributes to the mystification of science and scientists by describing the individuals he interviews as "majestic," "legendary," "spectacular," "a child prodigy," "a modern Isaiah," "a wizard," and "illustrious." What are common people to think when confronting such an array of godlike characters? But despite their awe, some readers may become skeptical of the wisdom of these men after learning of their pet peeves. For instance, Lorenz thinks the Mafia is the cause of many social problems, and biologist André Lwoff decries the dangers of animated cartoons.

Henri Laborit seems to be most clear on the issue of scientific hubris. When Salomon asks about the feasibility of setting up a "court" of experts to make decisions about health care, Laborit says that "inevitably their mentalities, their prejudices are stamped on the decisions they make. You'll never see a teacher or a mechanic on one of those committees; and yet they have as much good sense, if not more, than all the mandarins of science." Unfortunately, it is to the mandarins of science that Salomon has turned for wisdom in this book. □

Jonathan Beckwith is American Cancer Society Research Professor at Harvard Medical School.

A New World Economy

The World after Oil: The Shifting Axis of Power and Wealth
by Bruce Nussbaum
Simon & Schuster, 319 pp.

Reviewed by Jack D. Kirwan

The World after Oil is not futuristic. Bruce Nussbaum deals with the changing power and wealth among the world's nations brought on by advancing technology. Nussbaum, who covers international finance and business for *Business Week*, is like the knowledgeable guide on a tour bus. He urges the reader to look out the window while giving a running commentary on what's going on along the route.

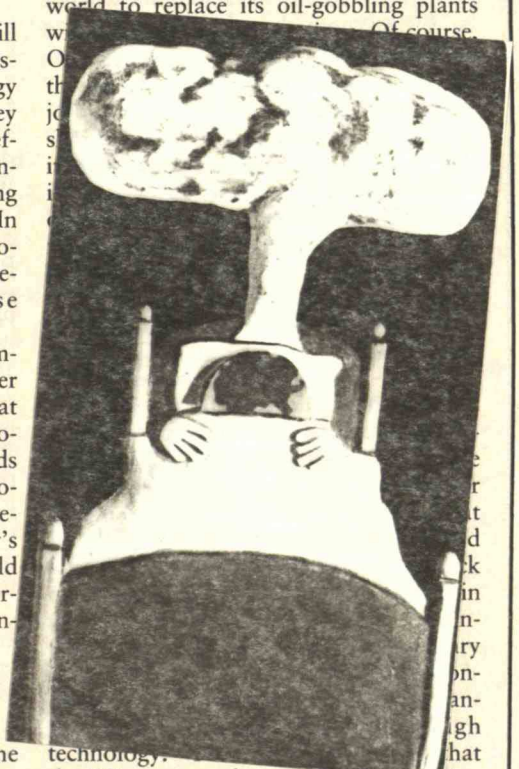
Nussbaum's basic premise is that "for the first time in 300 years, the political and economic axis of the world is shifting from the Atlantic Ocean to the Pacific Basin." Because the industrial era that brought us electricity, chemicals, and cars is passé, the nations who can best deal with newly emerging technologies will dominate the world economy.

The most important technologies will have three attributes, according to Nussbaum. They must not only use less energy but make things that use less energy, they must have an immediate and pervasive effect on people's lives, and they must increase productivity and efficiency by using less labor and fewer raw materials. In Nussbaum's view, only three technologies—robotics, bioengineering, and telecommunications—satisfy those requirements today.

Nussbaum sees robotics as the most important, even though it is now the sleeper of the trio. He makes a good case that "only the robot and the entirely automated factory of the future that it heralds can save the United States from its productivity quagmire—and a permanent decline of power." However, most of today's robots can only do one thing: spot-weld auto parts. The next step, already underway, is introduce robots with artificial senses such as sight and touch.

Making the Transition

Nussbaum thinks that, in particular, the OPEC countries, West Germany, and the Soviet Union will have trouble adapting to a new world economy. OPEC is not just resting between rounds but rather has suffered a technical knockout because of its own greed. By continually jacking up the price of oil, the cartel forced the industrial world to replace its oil-gobbling plants w... Of course, O... th... jo... s... i... i...



...technology. ...hat the "German tendency toward perfection and mechanical order that worked so well

Continued on page 78

(Continued from page 3)

Salvaging the Nuclear Option

The prescriptions of the various authors in "Rx for Nuclear Power" (*February/March, page 33*) omitted the most important medicine—a dose of the truth about the results of severe nuclear accidents. Such a clarification might help renew public and investor confidence and curb some of the most outrageous safety regulations.

The consequences of possible accidents at nuclear power plants have been greatly exaggerated over the last 20 years. Basic principles of chemistry and physics have been set aside, deliberately and arbitrarily, to ensure an ultraconservative assessment of the safety of reactors.

Actually, many safety studies and research performed in the United States and West Germany show that:

☐ Realistic assumptions about when radioactive material is released result in far less serious health effects than reported.

☐ The number of radioactive particulates released as aerosols is only a small fraction of that previously postulated.

☐ Large quantities of radioiodine will not be released into the environment during accidents of light-water reactors as previously assumed. Rather, the radioiodine combines to form iodides—principally cesium iodide, which is more soluble in water than table salt.

☐ In the event of an accident, radioactivity-laden water is retained in the plant, not dispersed to streams or groundwater by the cooling systems. The costly cleanup task created at Three Mile Island is evidence of how well the public is protected, even in a severe accident.

☐ A core meltdown accident, popularized as the catastrophic China syndrome, poses no greater threat to public health than many other industrial accidents. And evacuation plans may be more hazardous than any nuclear plant accident.

R. M. Campbell
Boston, Mass.

Since the first nuclear chain reaction produced energy from fission more than 40 years ago, scientists have tried to estimate the amount of radioactivity that could be released from malfunctioning reactors. The procedure now used to do this is called "probabilistic risk assessment," or PRA. Norman Rasmussen of M.I.T. developed this methodology for the *WASH-1400* study, which compares reactor hazards with everyday risks.

About 30 years ago, while at Argonne National Laboratory, I instigated tests in the Idaho desert to compare the actual and predicted behavior of a water reactor. After retiring to a safe distance of one-half mile from the reactor, we jerked out all its control rods. This caused major melting of the uranium-aluminum fuel and sent a high fountain of water above the uncontained reactor. As the core contained a large stockpile of radioactive fission products, we might have expected material to be widely distributed over the desert floor.

However, when I visited the area, I was struck by the small amount of radioactivity released. All the radioactivity on the desert floor was within about 100 yards of the uncontained reactor, and a simple estimate showed that only a very small portion of the core's radioactive material had escaped. Downwind measurements also showed that very little of the gaseous fission products had escaped. Thus, almost all the radioactivity from this open reactor was held either in the unmelted fuel or the remaining coolant water.

These so-called BORAX experiments have been extended in recent years. To my knowledge, these tests, as well as analyses of actual water-reactor malfunctions, confirm my conclusions that the results of a reactor meltdown are much less serious than expected from the assumptions in the *WASH-1400* report.

Milton Levenson, president of the American Nuclear Society, and Frank Rahn also reevaluated these assumptions recently under the auspices of the Electric Power Research Institute and reported their results in *Nuclear Technology* (May 1981). They concluded that one or two orders of magnitude less radioactivity would be released than predicted by *WASH-1400*. The most dangerous volatile fission products, the iodines, would be particularly well-contained. This is because the coolant must be both acid and oxygenated—each unlikely—for iodines to be released.

Through design changes, power density can be reduced so that reactors lose enough heat after shutdown to avoid a meltdown. As utilities gain more experience operating nuclear plants, people will begin to realize that reactors, to use computer lingo, are "user-friendly."

Samuel Untermyer
Mountain View, Calif.

AC Plasma Display Manufacturing

IBM

To: Ted
From: Bill
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list?
Thanks.

Vacuum tube digital multiplier
IBM 603/604 calculators
Selective Sequence Electronic Calculator (SSEC)
Tape drive vacuum column
Naval Ordnance Research Calculator (NORC)
Input/output channel
IBM 608 transistor calculator
FORTRAN
RAMAC and disks
First automated transistor production
Chain and train printers
Input/Output Control System (IOCS)
STRETCH computer
"Selectric" typewriter
SABRE airline reservation system
Removable disk pack
Virtual machine concept
Hypertape

System/360 compatible family
Operating System/360
Solid Logic Technology
System/360 Model 67/Time-Sharing System
One-transistor memory cell
Cache memory
Relational data base
First all-monolithic main memory
Thin-film recording head
Floppy disk
Tape group code recording
Systems Network Architecture
Federal cryptographic standard
Laser/electrophotographic printer
First 64K-bit chip mass production
First E-beam direct-write chip production
Thermal Conduction Module
288K-bit memory chip
Robotic control language

Bill—
We have a great story to tell about our manufacturing innovations. The mass production of our large-screen plasma display is an excellent example.
Ted

Figure 1. *The IBM 3290 Information Panel uses alternating current (AC) plasma technology, making possible high information content and distortion-free images. The screen, which is 10.7 inches by 13.4 inches, can display up to 10,000 characters and can simultaneously display four applications from one or more computers. Its great versatility allows it to mix graphics, images, and text.*

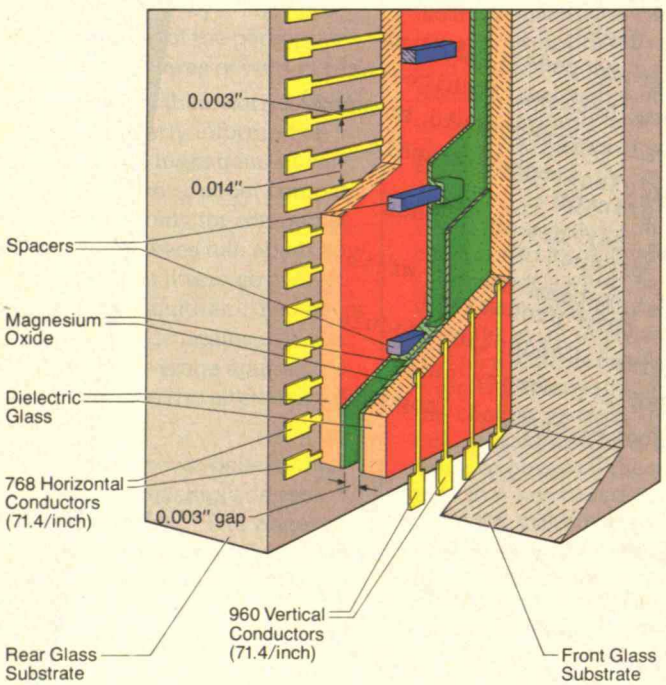


Figure 2. *This cross section of the plasma panel shows the narrow conductor lines on opposing glass substrates. Unique points on the panel can be ionized by applying low voltages to the appropriate horizontal and vertical conductors.*

Visual display terminals have had a profound impact on data processing. The IBM 3270 family of cathode ray tube (CRT) terminals has become widely accepted in the industry as a basic input/output device for mainframe computers.

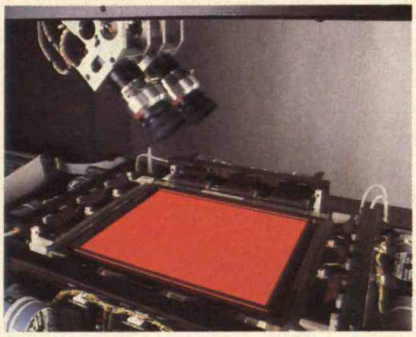
To display more data and to provide more advanced function without increasing space requirements, IBM has developed a new terminal using alternating current (AC) plasma display technology, invented at the University of Illinois. As a result of IBM's many manufacturing innovations, the IBM 3290 Information Panel, introduced in March 1983, is the industry's first mass-produced, large-screen plasma display terminal for commercial use.

HOW IT WORKS

In the IBM 3290, the plasma panel is a sealed sandwich of two glass plates: the rear plate is embedded with 768 parallel horizontal conductors and the front plate with 960 vertical conductors, thus forming a large grid. The narrow space separating the two plates is filled with inert neon-argon gas, which glows as electrical voltages are selectively applied to any of the over 700,000 intersections on the grid. This locally ionized gas, called a plasma, produces tiny dots of orange light. When combined in matrix patterns, these precisely located dots form images. Because this plasma technology operates

Figure 3. *The proximity printer shown here is one of many tools developed by IBM to mass-produce the AC plasma display panel. This machine automatically prints the hundreds of conductor lines on the glass plate by using highly collimated light to expose the conductor pattern through a mask. This projection printing system produces an excellent image and lowers the number of defects.*

Figure 4. *To assure consistently high quality in mass production, each AC plasma display panel is completely evaluated by this automatic tester developed by IBM. The tester has a camera system that scans and tests the patterns on each panel.*



in memory mode, the images do not have to be refreshed, eliminating any susceptibility to flicker.

MANUFACTURING INNOVATIONS

IBM manufacturing engineers had to find many answers to the challenges of mass-producing large-screen AC plasma panels. For example, special techniques were required to place 2,400 feet of very narrow conductors on each panel. To ensure high yields, engineers improved the method of photoprinting the conductor pattern and devised a way to repair open and shorted lines.

The large area of the new plasma display placed more stringent requirements on both the materials and processes used to fabricate the device. The panel—a composite of glass, metal, and thin-film oxide layers—is made by sequential thermal process steps, with each step conducted at a temperature suitably lower than the prior process step. To reduce material interactions, IBM developed lower-temperature dielectric glass and seal material.

To maintain a uniform chamber gap between the sandwiched glass plates, engineers also developed a new metallic spacer technology. The spacers—about the thickness of a human hair and a quarter inch long—are automatically bonded by a tool that uses a laser to keep placement tolerances within several ten-thousandths of an inch. The metallic spacers are nearly invisible in an operating display and do not interfere with the ionization process.

Many engineers at IBM contributed to the innovations that enabled the mass production of the plasma panels used in the IBM 3290 Information Panel. Their contributions are only part of IBM's continuing commitment to research, development, and manufacturing.

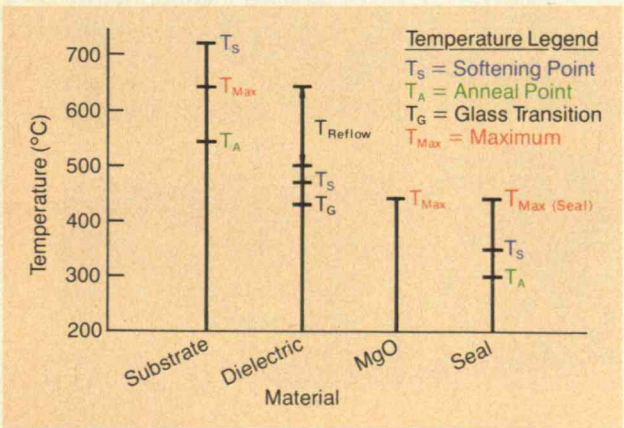
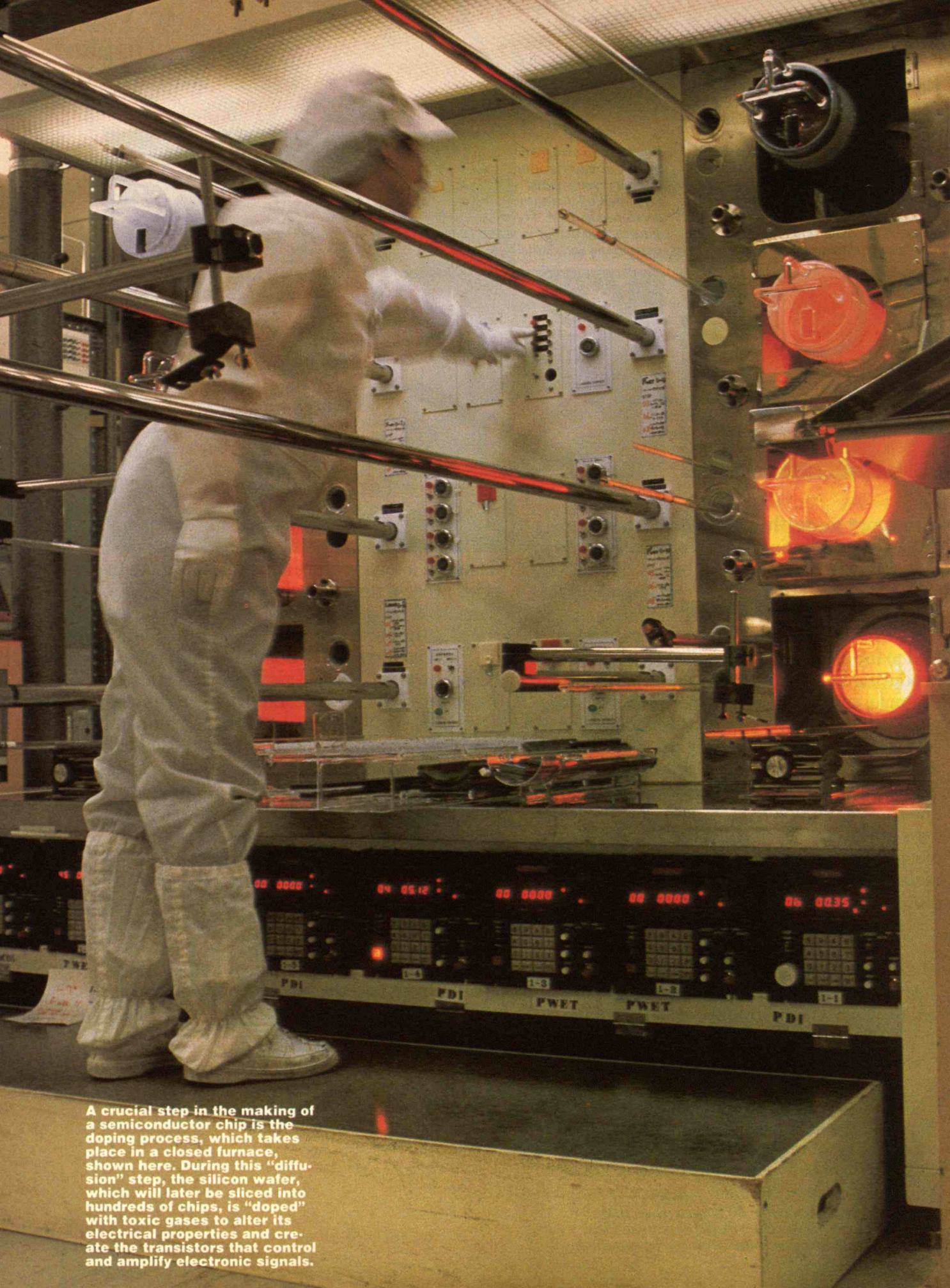


Figure 5. *To manufacture the AC plasma panel, IBM developed a lower-temperature dielectric glass and seal material to fit the thermal hierarchy requirements shown here.*

IBM®

For free additional information on AC plasma display technology, please write: IBM Corporation, Dept. 31H/978F Neighborhood Road, Kingston, NY 12401



A crucial step in the making of a semiconductor chip is the doping process, which takes place in a closed furnace, shown here. During this "diffusion" step, the silicon wafer, which will later be sliced into hundreds of chips, is "doped" with toxic gases to alter its electrical properties and create the transistors that control and amplify electronic signals.

The Not-So-Clean Business of Making Chips

WHEN the microelectronics industry was launched about 20 years ago, it was hailed as a clean industry that would pose few health and safety problems to its workers, and even fewer to the surrounding environment. Most people assumed microelectronics would entail processes similar to those of conventional electronics. They envisioned large numbers of workers quietly soldering conductive wires onto printed circuit boards. And because the slightest bit of dust could not be permitted to contaminate the semiconductor chip, the major product of this industry, the companies' operations appeared even cleaner than anticipated. Workrooms were thoroughly ventilated with filtered air and workers wore white gowns, head coverings, and gloves.

Microelectronics now has a world market of more than $19 billion and a workforce of more than one-half million people. But the clean reputation the industry has retained over the years is deceiving. Indeed, company health and safety records in California—one of the centers for manufacturing semiconductor chips—indicate that the industry has had an unusually high incidence of occupational illnesses. In a 1980 survey, the California Department of Industrial Relations found that the industry had 1.3 illnesses per 100 workers, compared with 0.4 per 100 workers for general manufacturing industries—or more than three times as many. Similarly, semiconductor companies have an alarming rate of occupational illnesses that result in lost work time; 18.6 percent of all cases that resulted in lost work time for semiconductor workers are occupational illnesses versus 6.0 percent for all manufacturing workers from 1980 to 1982.

Moreover, during the same period, compensation statistics show that 46.9 percent—or almost half—of all occupational illnesses among semiconductor workers in California resulted from exposure to toxic materials (called "systemic poisoning"). That was more than twice the incidence of illnesses from toxic exposures among workers in other manufacturing industries.

These facts suggest that the semiconductor indus-

BY JOSEPH LaDOU

The "clean" image of the microelectronics industry is misleading. The huge quantities of toxic materials used to make semiconductor chips pose far greater health problems than previously thought.

PHOTOGRAPH: MARV WOLF, AFTER IMAGE INC.

Secrecy prevails in the microelectronics industry, making it difficult to obtain information on manufacturing processes.

try, which uses large quantities of toxic metals, chemicals, and gases, may be creating significantly greater health and safety problems for its workers than heretofore realized. Some health and safety professionals are particularly concerned about the effects of these materials on the reproductive health of the industry's largely female workforce, many of whom are of childbearing age. The use of highly toxic and flammable materials also poses a serious threat to the safety of residents in surrounding communities. For instance, the rupture of one cylinder containing a toxic gas such as arsine could cause widespread acute exposures among local residents. Recent findings also show that the industry is contaminating the groundwater of nearby communities and polluting the air with photochemical smog.

The Making of a Chip

Before we discuss these problems in detail, it may be helpful to describe the basic process used to manufacture semiconductor chips. This information is not easily obtained because microelectronics is an industry where secrecy prevails. Furthermore, the technology advances so rapidly that processes and materials are constantly changing. This compounds the problem of determining the safety of workers: by the time the effects of a chemical or gas are fully realized, it may already have been replaced by another material.

In its simplest form, the manufacture of semiconductor chips begins with the preparation of silicon crystals. Elemental silicon is reduced from its oxide—the main constituent of common sand—and purified by a series of chemical additions. The silicon is then melted in a crucible at 1,420°C in an atmosphere of inert gas to prevent oxidation and unwanted impurities. Dopants—typically arsenic, phosphorus, and boron—are added during this step to enhance electrical conductivity. A perfect single-crystal silicon seed is inserted into the melted silicon and slowly twisted and withdrawn from the crucible. The resulting silicon ingot can be three to six inches in diameter and several feet long. The rounded ingot is sliced into thin wafers using a high-speed diamond blade saw. Finally, the wafers are ground and buffed, with one side given a flawless, polished surface.

The wafers are cleaned in baths of sulfuric and nitric acids and a variety of solvents to remove grease and other unwanted substances. They are then heated to between 1,000° and 1,200°C in an atmosphere of oxygen and water vapor to develop a silicon-dioxide film on their surfaces. This hard film is durable and serves as a nonconductive insulator.

The process of making semiconductors is very similar to photolithography in printing. The microelectronic circuit is built up layer by layer, each layer receiving a pattern from a mask prescribed in the circuit design. In the most basic method, an oxidized wafer is coated with photoresist—a light-sensitive material dissolved in a solvent—and the resulting film is baked dry. The most important property of the photoresist is that exposure to ultraviolet radiation alters its solubility in certain solvents. Thus, when a mask is applied to allow selective ultraviolet exposure, precise areas where the photoresist is exposed are polymerized. Wherever the mask is opaque, the photoresist is removed with microscopic accuracy by washing it in a solvent.

The wafer, equipped with its polymerized photoresist pattern and its exposed silicon dioxide, is again hardened by heating and placed in a solution of hydrofluoric acid. The acid dissolves, or etches, the silicon-dioxide layer wherever it is unprotected but does not affect either the photoresist or the wafer itself. When the pattern has been etched into the silicon dioxide, the wafer is rinsed and dried, and the photoresist pattern is removed from it by other chemicals.

The wafer is next given baths in hydrochloric or hydrofluoric acid and heated to a temperature higher than boiling water to remove unexposed material from around the desired circuitry. This step is followed by a wash in distilled water. The wafer is then placed in a closed furnace containing a dopant derived from arsine, phosphine, or diborane gas and heated to 1,000°C. In this step, called diffusion, the dopants penetrate the surface of the wafer to alter its electrical characteristics and create localized regions with excess negative or positive electrical charge. These n-type or p-type dopant regions form the transistors—or active circuit elements that process electrical signals.

The photoresist, masking, acid-etching, and diffusion processes may be repeated for the same wafer many times. The wafer is then covered with aluminum and acid-etched to produce contact pads for connecting external wiring.

Defining Toxic Exposure: A Battle of Semantics

BY ALISON BASS

In California, a minor difference in semantics has mushroomed into a major controversy over whether workers in the semiconductor industry suffer from a high incidence of job-related illness.

The word in contention is "instantaneous"—as in instantaneous exposure to toxic chemicals. Officials in the California Department of Industrial Relations (CDIR) define instantaneous exposure as an "immediate," one-time accident such as the splashing of chemicals into the eye. They consider anything else to be an illness, not an injury. According to that definition, there is an unusually high incidence of occupational illness among workers who produce miniaturized computer chips.

Officials in the semiconductor industry, however, define "instantaneous" as "anything that occurs within a very short duration of time." State officials say many companies include the inhalation of toxic gases and chemical fumes (for up to three hours in one case) under that definition, recording such exposures as injuries, not illnesses. According to the industry's interpretation, there is a very low incidence of illness among the same workers.

At stake in this battle of linguistics is the semiconductor industry's long-cherished image as a "clean" business with a superior reputation for worker safety and health. If the state of California's interpretation is accepted as a national guideline for occupational disease, semiconductor companies throughout the United States could find themselves with a far greater health and safety problem than previously acknowledged.

California has become the pivotal state in this dispute for good reason. Although semiconductor plants are located all over the country (with concentrations in New England, Colorado, Texas, and New York), microelectronics firms in California employ 23 percent of all the semiconductor workers in the nation. In addition, many of the multinational companies that manufacture semiconductor chips are headquartered in California's Silicon Valley.

A Problem Revealed

California officials first began noticing an unusually high number of occupational illnesses among semiconductor workers in the late 1970s. In their 1977 and 1978 surveys of company health and safety records, CDIR officials found rates of illness twice as high as those among workers in general manufacturing industries. The ratio was 1.3 illnesses per 100 semiconductor workers, compared with 0.6 (in 1977) and 0.5 (in 1978) per 100 workers in general manufacturing. In 1979, the figure for occupational illness among semiconductor workers dropped to 0.8 per 100 workers, but in 1980 it rebounded to 1.3—three times the rate among workers in general manufacturing.

These statistics startled state officials, triggering an 18-month review of the semiconductor industry by the California Occupational Safety and Health Administration (CAL-OSHA), a division of CDIR, and another, more comprehensive study by the National Institute of Occupational Safety and Health. The figures also aroused considerable concern within the industry itself.

"Industry leaders were shocked at their own statistics," says Mary Alexander, a San Jose attorney who is chairwoman of the Law Committee of the American Industrial Hygiene Association. "So they decided to reevaluate how they kept their records."

The result, state officials say, was an industrywide change in the way California's semiconductor companies record occupational injuries and illnesses. On the recommendation of a consultant hired by the Semiconductor Industry Association (SIA), headquartered in San Jose, the companies decided to treat all "instantaneous" or "one-time" chemical exposures as injuries. (On the worker logs that every company is required to keep, an occupational injury is defined by the U.S. Bureau of Labor Statistics [BLS] as a "one-time" exposure. The bureau does not clarify just what "one-time" means.)

The result was a "marked decline" in the rate of occupational illnesses among semiconductor workers, according to CDIR officials. They refuse to disclose the exact statistics for 1981 because they don't want to "authenticate" data that the industry might later use to prove that its plants are safe. But according to statistics for the entire California electronics industry, which includes the semiconductor manufacturers, the rate of illness dropped from .9 per 100 workers to .3 per 100 workers in 1981. State officials also refuse to release the final statistics for 1982, but sources within the department say they again point to a very low incidence of occupational illness among semiconductor workers.

"I don't know of any other trade association that decided to make an industrywide change in record keeping like this," says Charles Powell, deputy chief of health for CAL-OSHA. "If individual companies had considered it, the change would not have been as dramatic."

Industry officials maintain that the change was legitimate and necessary. Until 1981, they say, most of California's semiconductor firms were "overrecording" their occupational health data. "We just wanted to make the record keeping consistent," says Thomas Hinkleman, executive director of the SIA. "Some companies were re-

Continued on page 31

ILLUSTRATION: LUCY DILLON RASTETTER

Workers may not be aware that they are being exposed to chemicals and gases because of air-filtering systems.

The completed wafer has scores of individual integrated-circuit chips built up on its surface. Each chip is inspected by microscope and computer tested for accuracy. The wafer is then sliced into separate chips using a laser or a diamond blade saw. The chips are placed in ceramic frames and bonded with metal contact wires, and finally sealed with epoxy and tested for air tightness by being placed in radioactive krypton. There are, of course, many hundreds of advanced techniques beyond this basic semiconductor process.

Skewed Statistics

At first glance, statistics on occupational injuries and illnesses, derived from California workers' compensation records, seem to support the opinion that workers in the semiconductor industry are at less risk than those in other industries. In 1980, for example, the semiconductor industry had 7.6 injuries and illnesses per 100 employees, compared with 13.1 per 100 for all manufacturing industries, according to the California Department of Industrial Relations.

However, such statistics do not present a true picture of the semiconductor industry for several reasons. First, semiconductor workers are seldom exposed to heavy machinery with dangerous moving parts. Second, the ventilation and air-filtering systems used to safeguard the product from dust dissipate small gas leaks and the airborne products of chemical spills. Workers may not even be aware that they are being exposed to chemicals and gases because of the air-filtering systems. However, these systems do not alter chemicals except to dilute and recirculate them; and smocks and head gear do not protect workers from toxic exposures.

Finally, the lower incidence of health and safety problems reported by semiconductor companies may result from the inherent nature of the workforce. In the semiconductor industry, the greatest proportion of the workforce consists of managers, engineers, technicians, and business and clerical workers, who are seldom exposed to manufacturing hazards. In contrast, most employees in heavy-manufacturing industries are production workers who are exposed to such hazards. Moreover, most workers in the semiconductor industry are women and minorities, who tend to change jobs more often than production workers in other industries. Their high turnover rate could further skew statistics on health and safety problems in the microelectronics industry.

Toxic Materials by the Gallon

In 1980, the California Department of Industrial Relations asked 53 semiconductor companies to provide information on their use of various materials, and 42 companies responded. Many companies gave only partial reports on the requested materials or simply did not report some materials at all. Nonetheless, the investigation revealed the use of strikingly large quantities of chemicals and toxic gases. The 42 companies reported that in 1979 they used more than one-half million gallons of solvents, more than two million gallons of acid (primarily sulfuric, hydrofluoric, and acetic acids), and more than half a million gallons of caustics (mostly sodium hydroxide). Most alarming, however, was the fact that this relatively small number of companies reported handling more than one and one-half million cubic feet of cylinder gases, including highly toxic arsine, phosphine, and diborane.

Most chemical mixtures are sold under brand names. The law does require manufacturers of industrial materials to provide users with information on material content, hazardous components, and health risks, as well as possible precautionary methods. But the material safety data sheets (MSDSs) used to provide this information leave much to be desired. Most provide little detail that would be helpful in case of industrial exposure. Few semiconductor companies do more than compile manuals of the MSDSs for employee reference, and even fewer attempt to interpret the information for their employees. Moreover, manufacturers of these materials frequently omit information on their contents to protect proprietary materials. It is difficult even for health and safety professionals to obtain critical information on the contents of some materials used in semiconductor manufacture.

Early Health Problems

Initially, physicians treating workers from semiconductor companies shared the general consensus that the industry was clean. The majority of patients referred to physicians complained of typical work-related injuries, such as back strains and other

Semiconductor companies use millions of cubic feet of toxic gases compressed inside large metal cylinders such as these. The cylinders are trucked to the plants and connected to diffusion furnaces by stainless-steel gas lines. The accidental rupture of a 20-pound cylinder containing 100 percent phosphine would spread the gas over 1,792 acres—or 276 city blocks—before being diluted to a safe level of exposure.

musculoskeletal problems. But new problems soon began to appear. Workers increasingly reported hydrofluoric acid burns on hands, arms, face, and other exposed areas. If not immediately washed and neutralized, the burns caused severe damage to deep tissues as the acid passed through the skin. The large number of hydrofluoric-acid burns provided the first indication that semiconductor fabrication shared with other industries a significant level of risk to workers.

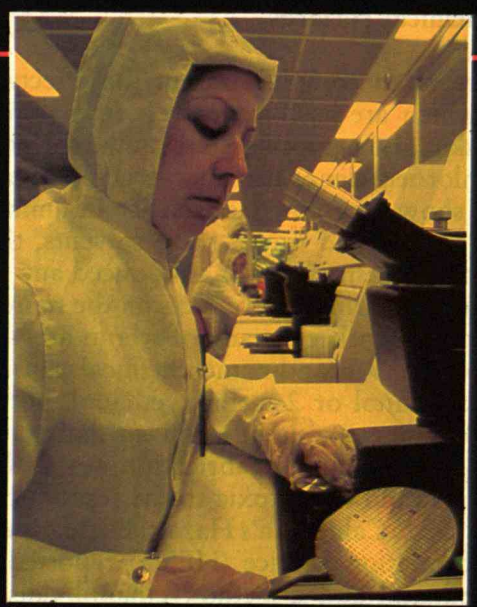
Manufacturers of semiconductor chips have recently begun to replace acid "wet etching" with a process called "dry plasma etching." This process has the advantage of being conducted in a closed chamber system, which is thought to be safer for workers. The plasma—or field of charged particles—used in this process is typically a cloud of high-energy fluoride radicals released from a material such as a Freon solvent. Dry plasma etching uses a large number of toxic and potentially dangerous materials, including chlorine gas and nitrogen trifluoride. The process also uses an energy source—radiofrequency—whose health effects are largely unknown. It is possible that one hazard (acids) has simply been replaced by another that will be even more difficult to evaluate. Radiofrequency power is also used in a number of other wafer-layering machines used in semiconductor manufacture, including epitaxial reactors and metallization equipment.

The Chemical Hazards

Workers often complain about the effects of solvents, which are used extensively in making chips, on the skin and nervous system. Some solvents, such as trichloroethylene, are carcinogenic in animals. Others show reproductive toxicity in animals. But despite widespread use of these solvents, the semiconductor industry has not announced any research aimed at measuring their effects on the reproductive health of its workers, many of whom are women.

Cellosolve, a brand-name chemical consisting of 2-ethoxyethanol or 2-methoxyethanol, both glycol ethers, is one example of a solvent that is regularly used in semiconductor fabrication—even though it has been found to be toxic to the reproductive system. In 1982, California's Hazard Evaluation System and Information Service (HESIS) reported that 2-ethoxyethanol and 2-methoxyethanol caused birth defects; resulted in the death of embryos in female

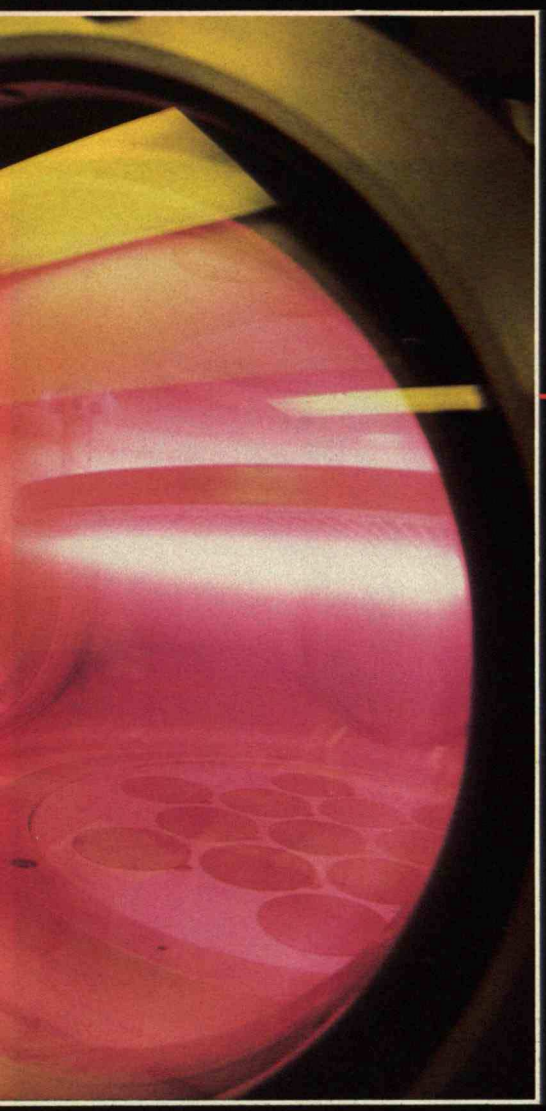
1

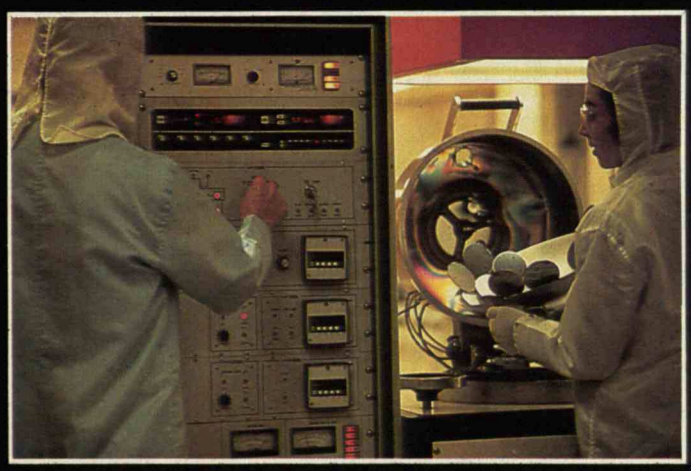


2

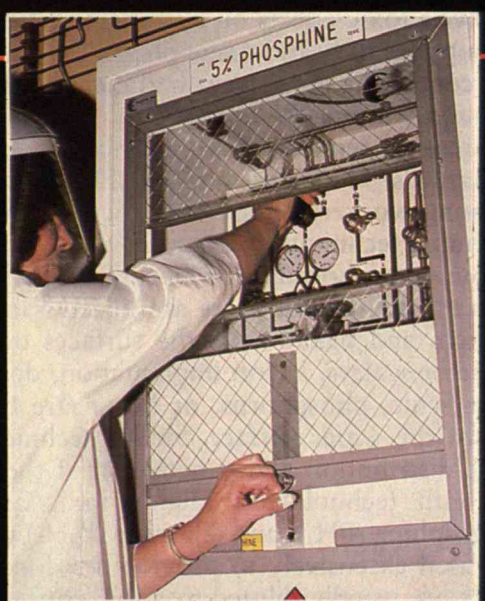
3

4





6

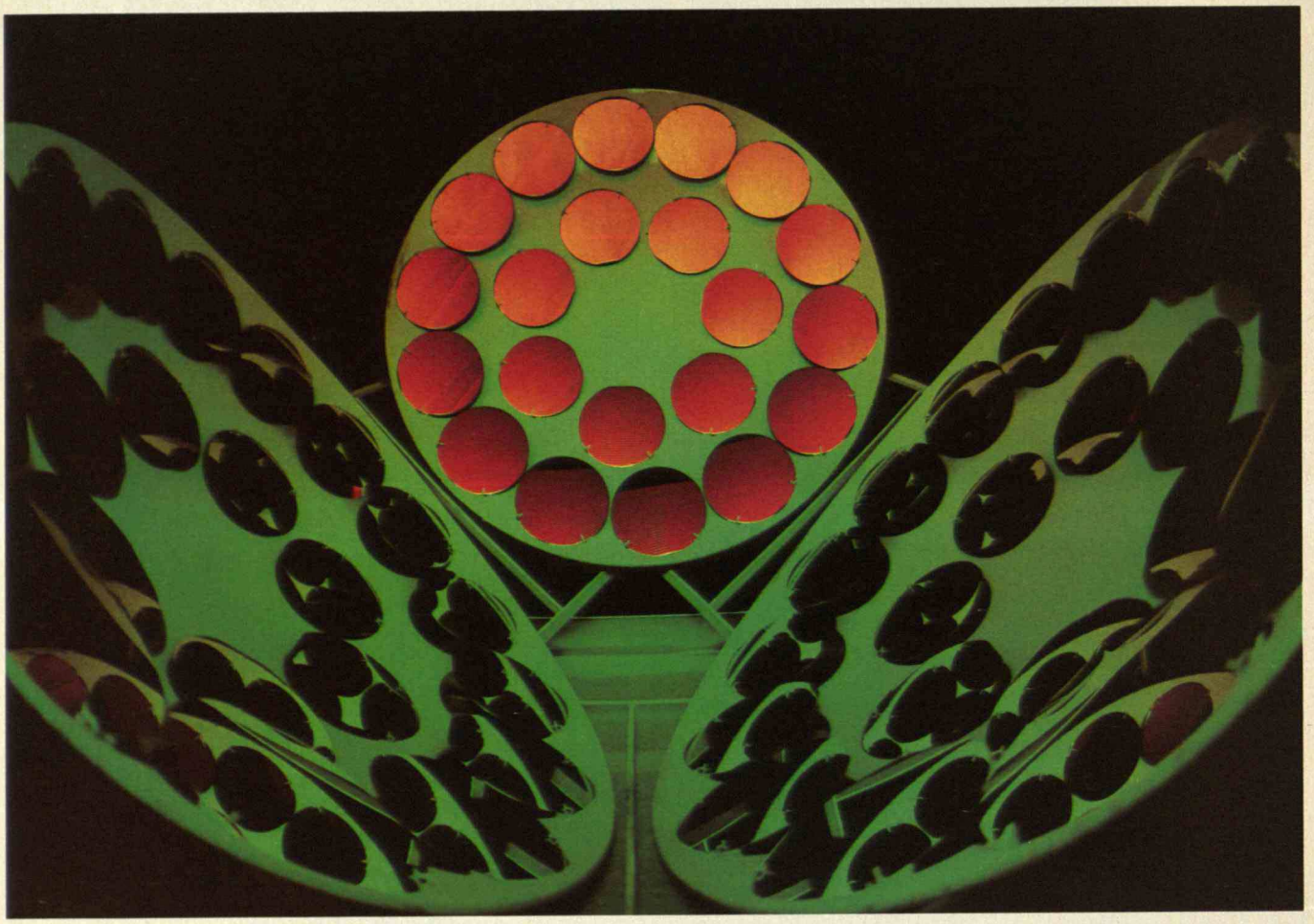


5

Silicon, one of the most abundant elements on earth, is the substance from which most semiconductor chips are made. Purified silicon is melted and twisted into long ingots, which are then sliced into thin wafers. The wafers are cleaned in acid and solvent baths to remove grease and other substances (1). Then each wafer is insulated with a film of silicon dioxide and coated with a light-sensitive material called photoresist. A mask is applied and the wafer is flooded with ultraviolet light, hardening the exposed portion of the photoresist (2). Solvents dissolve the unexposed photoresist, leaving a pattern to be etched into the silicon dioxide by hydrofluoric acid (3) or superhot gases in a closed chamber (4). The wafer is again bathed in acid and washed with distilled water. It is then placed inside a furnace and "doped" with small amounts of phosphine, arsine, or diborane gas to alter its electrical properties (5). These steps are repeated on the same wafer many times, building up its microelectronics circuit layer by layer. Finally, the wafer is placed inside a rotating device that uniformly deposits an aluminum film on its surface (6). The completed wafer is sliced into hundreds of individual chips, each small enough for an ant to cart away.

PHOTOGRAPHS: CHARLES O'REAR, WEST LIGHT; JOSEPH LA DOU

It is very difficult for physicians to diagnose low-level exposure to toxic gas.



mice, rats, and rabbits; and impaired sperm development in male animals. Although the HESIS report stated that "clear evidence for effects in humans is not available at this time," it recommended to its advisory committee that the limits of exposure to Cellosolve be lowered.

Because of these studies, certain manufacturers of glycol ethers did lower their recommended exposure limits for industry workers. Dow Chemical USA established a threshold limit of 3 parts per million (ppm) for 2-methoxyethanol and 5 ppm for 2-ethoxyethanol. But some companies that add Cellosolve to proprietary mixtures may choose to ignore these recommended exposure limits. In fact, only by carefully searching the MSDSs from a variety of suppliers would one discover that a solvent labelled as S-17 is 100 percent Cellosolve, that AZ Thinner is 80 percent Cellosolve, and that AZ-1350 J Photoresist and PBS Resist are 60 percent Cellosolve. At the time of this writing, almost two years after the discovery of Cellosolve's toxic effects on reproductive health, only one supplier of brand-name photolithographic chemicals containing the solvent had included these findings and a warning in its MSDS.

Other areas of semiconductor fabrication entail different hazards. The rising number of health complaints among workers parallels an increase in the use of advanced techniques for doping silicon wafers with arsenic, phosphorous, and boron. With diffusion furnaces, the dopant gases are injected into a closed system and baked onto the surfaces of the semiconductor wafers. In ion implantation, dopant atoms of arsenic, phosphorus, or boron are bombarded onto the wafer surface. Skilled technicians control the distribution and penetration of the dopants in both technologies. Highly toxic arsine (AsH_3), phosphine (PH_3), and diborane (B_2H_6) gases are being used extensively to provide the dopants. These gases are usually diluted to a low concentration, but some techniques now employ higher con-

A Battle of Semantics

Continued from p. 25

cording all chemical burns as illnesses when they should have been recorded as injuries. Also, if there was a presumed exposure and the company sent 100 people to the doctor, it would record 100 illnesses. But it makes no sense to record a presumed exposure as an illness if there are no symptoms."

Charges of Underreporting

To some local health and safety professionals, however, the industry's actions smacked of a coverup. In the spring of 1983, one of those professionals, a San Jose physician who treats Silicon Valley workers, made an official complaint to the state, charging the semiconductor industry with deliberately underreporting occupational illnesses among workers exposed to toxic chemicals. State officials declined to release the physician's name.

The state decided to investigate, sending compliance officers to check the health and safety records of six of the largest semiconductor firms in Silicon Valley as a representative sample. They found that all six companies were using the undefined language on the worker logs as a "loophole" to record inhalations of toxic materials as injuries, according to Karen Jones, an official in CDIR's Division of Labor Statistics and Research, which conducted the investigation.

"If a worker, for instance, reported inhaling arsine gas for a lengthy period of time—from several hours up to one day—that would be considered a one-time exposure and recorded as an injury," says Jones. State officials say that one reason the companies do this is because they do not have to report injuries that do not result in lost work time to CAL-OSHA. However, the industry must report all illnesses, whether or not they result in lost work time.

State officials also found that some companies were not recording toxic exposures at all—as long as the worker had no visible symptoms and there was no diagnosis by a physician. "In one case, a worker exposed to toxic inhalation for three or four hours experienced nausea and vomiting," said a CDIR official who asked to remain anonymous. "But by the time that worker got to the doctor, there were no symptoms, so the case was just regarded as first-aid and not recorded."

During the heat of the investigation, both state and industry officials sought a clarification of the position of the Bureau of Labor Statistics on the recording of occupational illnesses and injuries. In a written reply, William Mead, then the bureau's associate commissioner, noted that "injuries are caused by instantaneous exposure in the work environment; cases resulting from anything other than instantaneous events are illnesses. This concept encompasses acute illnesses that result from exposures of relatively short duration."

Although Mead provided no written definition of "instantaneous" in that letter, he later furnished state officials with more precise guidelines by ruling on 40 specific cases of illness and injury among California microelectronics workers. Mead concluded that only two types of toxic exposure, other than chemical splashes, could be considered "instantaneous events" and therefore injuries. He cited one example involving a worker who was exposed to hydrochloric-acid fumes as she walked by an open door. The second involved a plumber who was "hit in the face" with a puff of hydrochloric gas while removing a gas line from a furnace. Mead said all other types of exposures that resulted in an abnormal condition, from a sore throat and headache to more serious symptoms, should be classified as illnesses. In this category, he included specific cases of workers exposed to fumes from a chemical solvent such as trichloroethane, and to toxic gases such as arsine, for two minutes or more.

"I backed up the state 100 percent," says Mead, who has since retired. "The industry was saying that the national office had a different interpretation than California. That's not correct. We have the same interpretation as the state of California."

State Kills Investigation

Despite Mead's support, however, CDIR decided to drop the investigation, as well as efforts to obtain industry compliance with the state's interpretation. Today California's semiconductor industry continues to interpret instantaneous or one-time exposure as "anything that occurs within a small time frame," says Hinkleman. And according to officials from BLS, semiconductor companies throughout the United States are following California's lead. "In most industries, most companies record any kind of toxic exposure as an illness, not an injury," says Steven Newell, a research analyst with the BLS. "But the semiconductor industry has apparently decided it's in their best interest to go the other way."

Some health and safety professionals are disturbed by CDIR's decision to kill the investigation. They say it was dropped because it became too hot politically. "Basically, industry leaders called the national OSHA office and OSHA officials put pressure on the state officials," says Mary Alexander.

Hinkleman says "the only pressure industry has used is to go to the federal government and ask for an interpretation." However, one CDIR official confirmed that the industry wielded its influence to stop the state from citing the companies under investigation. "The semiconductor industry is getting hit from all directions," says this official, who asked to remain anonymous. "They're very defensive." The industry's other problems include charges by Silicon Valley residents that chip-making plants are contaminating groundwater.

CAL-OSHA's Powell says the state was unable to cite any of the companies for a violation because they were following the "letter of the [national] regulation." Powell blames the BLS for dispersing guidelines that allow too much room for interpretation. "At best the regulation is vague," he says. "It makes it extremely difficult for local government to make sense out of what industry reports."

BLS officials say they are now working on new national guidelines that will provide specific examples of just what constitutes an injury or illness. Once these guidelines are published, Newell says they should "put a lot of this stuff to rest."

The new guidelines still don't define "instantaneous," but BLS officials don't think a definition is necessary. "The basic definition of injury involves a single instantaneous moment of contact," says Herb Schaffer, acting associate commissioner of the BLS. "All you have to do is look it up in Webster's Dictionary."

ALISON BASS is a senior editor of Technology Review.

Not surprisingly, the use of arsenic in making chips has aroused the concern of health professionals.

centrations that increase the potential for toxic exposure. For instance, a growing number of semiconductor companies use 100 percent phosphine in the doping process. This high a concentration is not necessary, but is merely a convenience to avoid changing cylinders as often as would be required with cylinders of lower concentrations.

Semiconductor workers are probably often exposed to low levels of toxic gases, but air exchangers carry away the results of minor leaks before sensors can detect them. Furthermore, it is very difficult for physicians to diagnose low levels of toxic gas inhalation. Exposure to trace amounts of toxic gas usually does not produce symptoms, and very few gases produce readily identifiable symptoms even at high exposures. Blood tests and other clinical studies seldom pinpoint gases as a cause of symptoms, although workers and their employers mistakenly believe that they can. Thus, few cases of toxic inhalation are reported in California annually—not because they do not occur but because they are so difficult to diagnose and document.

The Arsenic Debate

Arsenic is one of many materials used in semiconductor manufacture that is widely recognized to be a health hazard. It is actually a common trace metal in our diet. The arsenic found in fish, for instance, is organically bound and not toxic to mammals. But trivalent arsenic trioxide (arsenite)—the form most commonly used in industry—*is* toxic to humans. Numerous studies of workers in metal-smelting and other industries that generate large quantities of arsenic as a by-product have shown that it is carcinogenic. According to these studies, smelter workers are more likely than other workers to die from cancer of the lungs, bronchi, lymph glands, and the tissues that manufacture blood. Arsenic trioxide is also associated with skin cancers in chemical workers and wine makers, and with liver cancer in people exposed to arsenic-contaminated drinking water or wine.

Not surprisingly, the use of arsenic in semiconductor fabrication has aroused the concern of health and safety professionals. Yet it is being used in ever-larger quantities because higher-speed microelectronic devices often require wafers composed of equal parts of arsenic and gallium. The current debate over the safety of the gallium-arsenide wafer itself obscures the important hazards in handling the arsenic involved in its manufacture. Three pounds of arsenic are used in a typical gallium-arsenide ingot, compared with the milligram quantities of arsenic in a silicon ingot. As a result, production of gallium-arsenide wafers requires much greater care to contain the toxic arsenic powder so that workers are not endangered. To prevent exposure, equal measures of arsenic and gallium are heated in a closed system. Nonetheless, investigators from the California Occupational Safety and Health Administration (CAL-OSHA) found unsafe levels of airborne arsenic dust near workers involved in this process. Many firms are seeking safer methods, but too few are seeking alternative materials.

Arsine gas is the other toxic form of arsenic to which semiconductor workers are exposed. Acute inhalation can cause rapid destruction of red blood cells, followed by severe kidney damage, and—if the patient is not immediately treated—death. Given sufficient low-level exposure over time, arsine also may be carcinogenic.

Until recently, many health professionals contended that the arsenic found in the urine samples of workers came from arsenic in food—not to be confused with industrial arsine or arsenite. Thus, occasional measurements of urinary arsenic above an arbitrary level of 50 micrograms per liter were written off as the result of diets high in seafood, red wine, or contaminated drinking water, or smoking.

But few assumptions remain unchallenged in the field of occupational health. In a recent study, scientists from the National Institute for Occupational Safety and Health (NIOSH) found a strong correlation between arsine concentrations in the air of a lead-acid battery plant and urinary excretions of arsenic among workers in that plant. (Arsenic is used in battery production as an alloy with lead and gives off arsine gas when in contact with acid.) The investigators found arsenic concentrations of 50 micrograms per liter or above in the urine of 8 of 39 workers. All 8 were employed in production and 6 were in battery formation, which had the highest levels of arsine exposure in the plant. The scientists also found that workers who repeatedly inhaled arsine gas at less than one-tenth the OSHA standard of 200 micrograms per cubic meter excreted enough arsenic to suggest possible carcinogenic results. This indicates that chronic arsine exposure, with the at-

The Case of the Toxic Solvent

In the winter of 1979, several hundred workers at a newly opened electronics plant in Colorado began complaining of upper respiratory problems. Some of the workers reported difficulty in breathing, others complained about constant coughing and wheezing. The company physician might have dismissed these maladies as an outbreak of the common cold—it was, after all, that time of the year—but for one other factor. Among the routine lab tests of workers in the plant, the physician had noticed a large number of abnormally high counts of a particular type of white blood cell, called eosinophil. And some of those abnormal results belonged to the people complaining of respiratory problems. The physician, an internist with little experience in occupational disease, was baffled. So he picked up the phone and called an old friend who specialized in occupational toxicology.

"Many company physicians might not have ever bothered to make that call," says Dr. Dan Teitelbaum, a Denver internist and toxicologist who has worked extensively with the microelectronics industry on health and safety issues. As director of occupational medicine for the Denver Clinic, he was the specialist who received the call. "More often than not, contracted physicians, who are usually retained instead of an in-house physician by companies with less than 1,000 workers, wouldn't know what they were looking at, either. Some haven't the faintest idea of what workers do. They only treat acute injuries."

The company whose physician sought Teitelbaum's help is not small by industry standards; it has 3,000 employees and a good-sized medical team that includes several full-time nurses and three doctors. The company produces the magnetic tapes used to store data in mainframe computers. Its production process depends on many of the same chemical solvents used in manufacturing miniaturized computer chips. In fact, the chemical that was finally identified as the culprit in the 1979 outbreak is commonly used in the semiconductor industry, says Teitelbaum.

The Blood-Count Clue

When Teitelbaum was first contacted by the company's physician, he says he had a "gut feeling" that occupational asthma was involved.

"Elevated eosinophil counts usually show the presence of an allergy," Teitelbaum explains. "It turned out that 300 people had reported some degree of respiratory allergic response. The question was to what."

With the help of company officials, Teitelbaum proceeded to study all the toxic materials used in the manufacturing process, examining the literature for their known medical effects and identifying their particular purpose. Teitelbaum also interviewed the employees with abnormal blood samples and upper respiratory problems.

"We found that most of those workers were maintenance people who worked on the machines used to put magnetic coating on the tapes," Teitelbaum recalls. "They were most exposed to the residue of the solvent because they were working barehanded, without suits or respirators."

The medical sleuths then discovered that one of the solvents used in the magnetic-coating process had provoked similar outbreaks of asthma among workers in the company that produced the chemical. At that point, it was relatively easy to pinpoint the offending agent: ethylene diamine (EDA), a common industrial solvent.

Occupational studies have shown that acute exposure to ethylene diamine can provoke an asthmatic attack severe enough to require hospitalization, says Teitelbaum. Although little is known about the effects of long-term exposure, Teitelbaum believes it may cause pulmonary disease such as emphysema.

The manufacturers of ethylene diamine knew about its acute—if not its chronic—effects, according to Teitelbaum. But they didn't include those facts in the safety data sheets handed out to their own employees and to companies such as the Colorado electronics firm that purchase the solvent.

"Basically, they lied to their workers and their consumers. It was a deliberate attempt to deny information," Teitelbaum says. "Unfortunately, that's typical of too many companies."

The Company's Response

However, Teitelbaum says that once the cause of the asthmatic outbreak was determined, the electronics company that used EDA immediately took steps to protect workers from further exposure. The company instituted a medical surveillance program and required all employees to wear gloves, respirators, and suits whenever working near or with the chemical. The company also enclosed the magnetic-coating process as much as possible and installed better ventilation systems.

"The electronics company's response was prompt and vigorous," Teitelbaum says. "They spent a lot of money to find the answer and once it was found, they acted to correct the problem permanently." Teitelbaum notes that larger companies tend to move more quickly than smaller entrepreneurial firms in response to a documented health problem.

"Large companies have the money to act," he says. "Furthermore, most workers in that industry are nonunion, and company executives fear that health and safety will become a union issue. I don't like the motivation, but the net result is a good one."

Entrepreneurial Failings

However, in small, entrepreneurial companies, struggling to gain a foothold in the marketplace, health is not a very high priority. "Many smaller companies don't even know they should be training their employees to take effective precautions," Teitelbaum says. "They're just not as good with health and safety."

As a result, Tietelbaum says he is seeing "a lot more problems" in smaller plants—particularly with workers' being exposed to toxic chemicals and gases. And as the industry becomes more entrepreneurial, with rapid leaps in chip technology, he fears those problems will increase.

"It's a myth that this is a clean industry," Teitelbaum says. "You've got a large number of people working with highly toxic materials, and the problems are not defined because both the industry and the workforce are young."—*Alison Bass* □

Despite the absence of belching smokestacks, companies near San Francisco emit about nine tons of gases daily that form photochemical smog.

tendant risk of cancer, may occur without visible signs of red-cell destruction or kidney damage.

Equally important, insignificant amounts of urinary arsenic were measured in workers who reported eating seafood during the week prior to the study. The researchers concluded that arsenic in the urine could no longer be considered harmless reflections of dietary arsenic, but could well represent dangerous levels of exposure to arsine or arsenite. The problem for the semiconductor industry is that these findings were obtained in 1982, many years after arsenic and arsine gas were introduced into its manufacturing process. These findings emphasize the need for engineering controls, such as closed-system diffusion furnaces and glove boxes for workers handling toxic materials, to reduce exposure.

Electrical shock is another important health hazard in the semiconductor industry. Instruments using 110 volts are often combined with power voltages of 200 to 500 volts. Some equipment may even require voltages of 10,000 volts or higher. No accurate survey has determined the number of deaths from electrocution in the industry. However, the deaths of five workers were reported at a recent meeting of the Semiconductor Safety Association. Two of the deaths were the result of working with 10,000-volt machines and could have been prevented by electrical lockout devices.

It is not an overstatement to say that the semiconductor industry provides a complete spectrum of the occupational hazards found in most industries, including exposures to chemicals, gases, metals, and ionizing and nonionizing radiation, as well as such dangers as explosion, fire, and electrocution.

Assessing the Hazards

Two national studies have found evidence of occupational health and safety problems in the semiconductor industry. A recent investigation by Battelle Corporation of Columbus, Ohio, and PEDCo Environmental of Cincinnati has revealed that some of the equipment used in the etching process emits higher-than-recommended levels of radiofrequency waves. The same group also found that production employees working with or near wafers following ion implantation can be exposed to concentrations of arsenic in excess of the safety standard for this carcinogen. They also found that maintenance workers suffer higher exposures to toxic gases such as arsine and phosphine than do production workers; such exposures usually occur while maintenance workers are changing metal cylinders and cleaning the equipment.

There were two disappointing aspects to this study, which was funded by NIOSH and the EPA. First, the study did not consider gallium arsenide production in detail. Investigators saw only one gallium arsenide operation and that was on a walk-through inspection. Thus, the potential for toxic exposure of workers using this process was largely ignored. Second, the researchers concentrated on major companies with accepted engineering controls. Thus, the results could not be considered typical of the semiconductor industry as a whole. The results would have been more informative if the researchers had surveyed the many companies that employ fewer than 200 workers. These companies pay much less attention to health and safety, and are able to invest fewer resources in engineering controls and health and safety programs.

Another study by the Brookhaven National Laboratory and the Research Triangle Institute, also under the aegis of NIOSH, suggests that the many different acids, gases, and metals used in the industry may react synergistically to the detriment of workers' health. Both studies indicate the need for more attention to health and safety, and for further studies of this growing worker population.

The Issue of Community Health

A serious and unexpected problem for the semiconductor industry surfaced two years ago, when residents of Silicon Valley discovered that private water wells were being contaminated by toxic materials leaking from underground chemical storage tanks. In April 1982, the California Regional Water Quality Control Board initiated an Underground Tank Leak Detection Program, through which 80 sites have been investigated. Of these, 64 (80 percent) have shown subsurface contamination of soil, groundwater, or both, and 57 will be investigated further because hazardous materials threaten to contaminate drinking water. Although this problem occurs at industrial sites throughout the San Francisco Bay area, Silicon Valley is the source of by far the largest number of underground leaks. The contam-

No community is prepared to handle the major disaster that could result from the rupture of a cylinder containing arsine gas.

inants identified include solvents, acids, metals, resins, and fuels that have leaked from storage tanks for products or raw materials, waste tanks and sumps, fuel tanks, and piping systems.

The most significant leak occurred at Fairchild Camera and Instrument Corporation in South San Jose. There, an underground fiberglass tank leaked an estimated 58,000 gallons of solvents, including trichloroethane, before being discovered. By the time the company reported the leak to the Great Oaks Water Co., an aquifer supplying drinking water to possibly thousands of people had already been contaminated. Fairchild has spent more than $12 million to develop 80 monitoring wells and 12 extraction wells to clean up the leak, and the company even recently closed down the plant. A multimillion-dollar lawsuit has been brought against the company, the water supplier, and various other defendants. There are already 267 plaintiffs, including 117 children, who charge that 13 deaths and a number of medical problems—birth defects, cancer, skin disorders, and blood diseases—resulted from groundwater contamination. IBM's large research center in San Jose now faces a similar charge of groundwater contamination.

After the Fairchild leak was discovered, city officials in Silicon Valley, with the help of industry representatives, developed a "model ordinance" for the underground storage of hazardous materials. The ordinance requires that all new underground tanks be built with double containment walls. It also requires local companies to monitor their storage tanks continuously for leaks, and to disclose publicly the types and amounts of materials stored. State legislation including some of those requirements has since been adopted.

The disposal of hazardous wastes by semiconductor companies further demonstrates the fallacy of the "clean-industry" reputation. California electronics companies discarded 65,000 tons of potentially toxic materials in hazardous-waste landfills in 1980, according to a report by the Governor's Office of Appropriate Technology. Supporting industries—which include electroplaters, plastics companies, and the like—added even more to the total. Because many hazardous-waste landfills are poorly located and the technology of waste disposal is largely untested, these wastes could pose a long-term environmental threat to surrounding communities.

How Clean Is the Air?

The San Francisco Bay Area Air Quality Management District plans to bring its nine-county region into compliance with the federal Clean Air Act by 1987. Despite the absence of belching smokestacks, the agency estimates that companies within the district emit about 9 tons of "reactive organic gases" a day. These compounds are involved in the formation of photochemical smog. District officials first proposed that local industry reduce this quantity by 6 tons a day. Meeting this requirement would cost the high-technology companies a total of $10 million to $14 million a year by 1987—an impossible outlay for many of the 238 companies.

In July 1983, the district decided to modify these requirements by allowing a reduction of 3 tons per day and giving industry an additional year to comply. A new rule that all sinks where solvents are used must be covered will reduce organic emissions by only about 1,000 pounds a day. Methods such as carbon adsorption and incineration, as well as conversion to cleaner photolithographic processes, can be used to cut the remaining 2.5 tons a day. Although these requirements are less stringent than those in the original proposal, officials say they are the first air-pollution controls imposed on the semiconductor industry anywhere in the country.

The EPA has also announced a new $500,000 pilot project to study environmental problems involving toxic chemicals, air, water, groundwater, and land in Silicon Valley. But while the EPA works with local agencies and industries to deal with pollution, an even larger danger may go unnoticed: the possibility of an accidental release into the community of toxic gases such as arsine, phosphine, and diborane. No community is adequately prepared to handle the major disaster that could result from the rupture of a metal cylinder containing arsine gas. Because this gas destroys red blood cells when it is inhaled, the only lifesaving procedure is a complete blood transfusion. But the combined emergency rooms of all the hospitals in most industrial communities could handle only a small number of such transfusions. Similarly, acute exposure to phosphine and diborane can cause an excessive buildup of fluids in the lungs and massive destruction of lung tissue. Widespread exposure to these toxic gases would be difficult for communities to handle. In addition,

Semiconductor firms should assign more of their revenues to health and safety programs.

these gases, as well as silane, another commonly used gas, are all highly flammable.

Many toxic gases are delivered in metal cylinders that have no uniform warning labels or color identification codes. These cylinders are connected to diffusion furnaces, ion implanters, and other devices by stainless-steel gas lines. Plant engineers and safety professionals do not agree on the best methods of handling them. Some are convinced that the cylinders should be kept outside the plant and the contents fed into the plant by gas lines; others argue that the safest method is to store the cylinders in specially designed cabinets within the work area.

Regardless of where they are stored, the gas cylinders must be handled with utmost care. If the contents of a cylinder containing 200 cubic feet of 10 percent arsine gas were released into a room of 10,000 cubic feet, they would produce a lethal concentration for 10 minutes, despite the air filtering and recirculation used in the semiconductor industry. The industry also uses 100 percent phosphine gas, which is both spontaneously flammable and extremely toxic. Acute exposure can cause death within a few minutes. The accidental release of the contents of a 20-pound cylinder of 100 percent phosphine would have to spread over 1,792 acres—or 276 city blocks—before being diluted to the permissible exposure level of 0.3 ppm.

The problem is not limited to the storage and handling of gases at semiconductor plants. It also includes the possibility of accidents involving trucks that transport these materials. No other industry in history has created such a demand for these hazardous gases. Yet the risks to community and workers are seldom discussed with candor.

Prescriptions for Health and Safety

The problems of health and safety in the semiconductor industry present a major challenge to both the industry and the communities in which it provides jobs and other economic benefits. The problems can be solved only with closer interaction among managers, plant engineers, health and safety professionals, and community representatives.

First, health professionals and community representatives should help engineers plan their company's operations, since the engineers may not be aware of health hazards. Police and fire personnel should learn about the hazardous processes and materials used in local plants so they can prepare a plan for emergency treatment and possible evacuation.

Second, the medical community should be informed of the hazardous conditions that exist for both workers and the community. Physicians will then be able to better diagnose worker health problems and assist communities in emergency planning.

Third—and perhaps most important—the semiconductor industry should seek to replace hazardous processes and materials with safer ones. Hazardous materials are often used simply because they were first used in the research laboratory.

Fourth, both industry and government should undertake comprehensive studies of the health and safety of high-technology workers. A major commitment for funding and follow-up would be required, since the new industry cannot be evaluated in terms of experience with traditional industries. New technologies will continue to create new problems of occupational health and safety, and each must be studied individually.

Finally, semiconductor companies must assign a larger part of their revenues to health and safety programs. Mature firms in other industries generally invest 2.5 to 3 percent of their revenues in such programs. The semiconductor industry, in contrast, is investing less than 1 percent. Of course, the industry is relatively young, and many beginning companies are small. However, worker and community well-being should become a higher priority as the semiconductor industry rapidly expands in size and importance to the world economy.

FURTHER READING

☐ Elliott, D.J., *Integrated Circuit Fabrication Technology*. New York: McGraw-Hill, 1982.

☐ Landrigan, P., R. Costello, and W. Stringer, "Occupational Exposure to Arsine: An Epidemiologic Reappraisal of Current Standards." *Scandinavian Journal of Work, Environment, and Health*, September 1982, pp. 169-177.

☐ Robinson, A.L., "GaAs Readied for High-Speed Microcircuits," *Science*, January 21, 1983, pp. 275-7.

☐ Williams, M., and R. Wade, *1981 Semiconductor Industry Study*. San Francisco: CAL-OSHA Communications, 1982.

JOSEPH LaDOU, M.D., is acting chief of the Division of Occupational and Environment Medicine, School of Medicine, at the University of California-San Francisco. He practices occupational medicine in Sunnyvale, Calif.

Batteries that may live seven times longer than the spacecraft themselves will be employed on Intelsat VI communications satellites to ensure performance. The nickel-hydrogen batteries provide power when the satellite slips into Earth's shadow and the solar cells no longer generate electricity. They have demonstrated 6,000 discharge cycles in tests, the equivalent of 70 years in geosynchronous orbit. Hughes Aircraft Company heads an international team building Intelsat VI for the International Telecommunications Satellite Organization.

A new video graphics projector that's brighter and sharper than conventional projection TV may be the next addition to office computer systems. The Hughes projector displays monochromatic computer-generated alphanumerics, symbols, and graphics. It could be used for displaying dynamic computer data and facsimile video pictures in board rooms and other areas, and for teleconferencing. The projector uses a device called a liquid-crystal light valve, a cousin of displays in digital watches. This device intensifies the image from a cathode-ray tube and projects it onto a screen up to 12 feet wide. The picture is so bright and has such high resolution that the viewing room needn't be darkened.

A novel engineering tool for producing the AMRAAM missile is expected to save the U.S. government and Hughes millions of dollars and months of work. A full-scale prototype of the Advanced Medium-Range Air-to-Air Missile has been completed using actual engineering drawings, materials, and processes. The purpose of this "precision physical model" is to refine AMRAAM's design and detect potential manufacturing problems, especially those stemming from late improvements. Among other things, the model has been used to determine routes and lengths for wire harnesses so that mating connectors will line up. It also was used in designing handling and test fixtures, and to show how its components react to vibration. AMRAAM is in full-scale development for the U.S. Air Force and Navy.

NATO early-warning aircraft are being equipped with a communications system that uses four primary encoding techniques to hamper enemy eavesdropping or jamming. The Joint Tactical Information Distribution System (JTIDS) provides E3A AWACS aircraft and NATO ground command centers with secure voice and digital communications. One JTIDS encryption technique is spread spectrum, in which a signal is expanded over a large bandwidth. With frequency hopping, a second method, frequencies are changed many times a second. Another technique, time division multiple access, assigns certain users to specific time slots no longer than a fraction of a second. Finally, to verify messages, JTIDS repeats messages automatically. Hughes is supplying JTIDS to NATO and the U.S. Air Force.

The Hughes Tucson facility, located in picturesque Southern Arizona, is a large, modern manufacturing complex with capabilities for producing advanced missile systems developed by Hughes. We have openings for experienced and graduating engineers to work on such advanced systems as the electro-optical Maverick, radar-guided Phoenix, TOW, and AMRAAM, the Advanced Medium-Range Air-to-Air Missile. Please send your resume to Professional Employment, Dept. S2, Hughes Aircraft Company, P.O. Box 11337, Tucson, AZ 85734. Equal opportunity employer.

Technology and Freedom in the Soviet Union

The Russian state has used technology to control its citizens for hundreds of years. But new forms of technology, combined with changing social mores, are encouraging the growth of individual freedom in the Soviet Union.

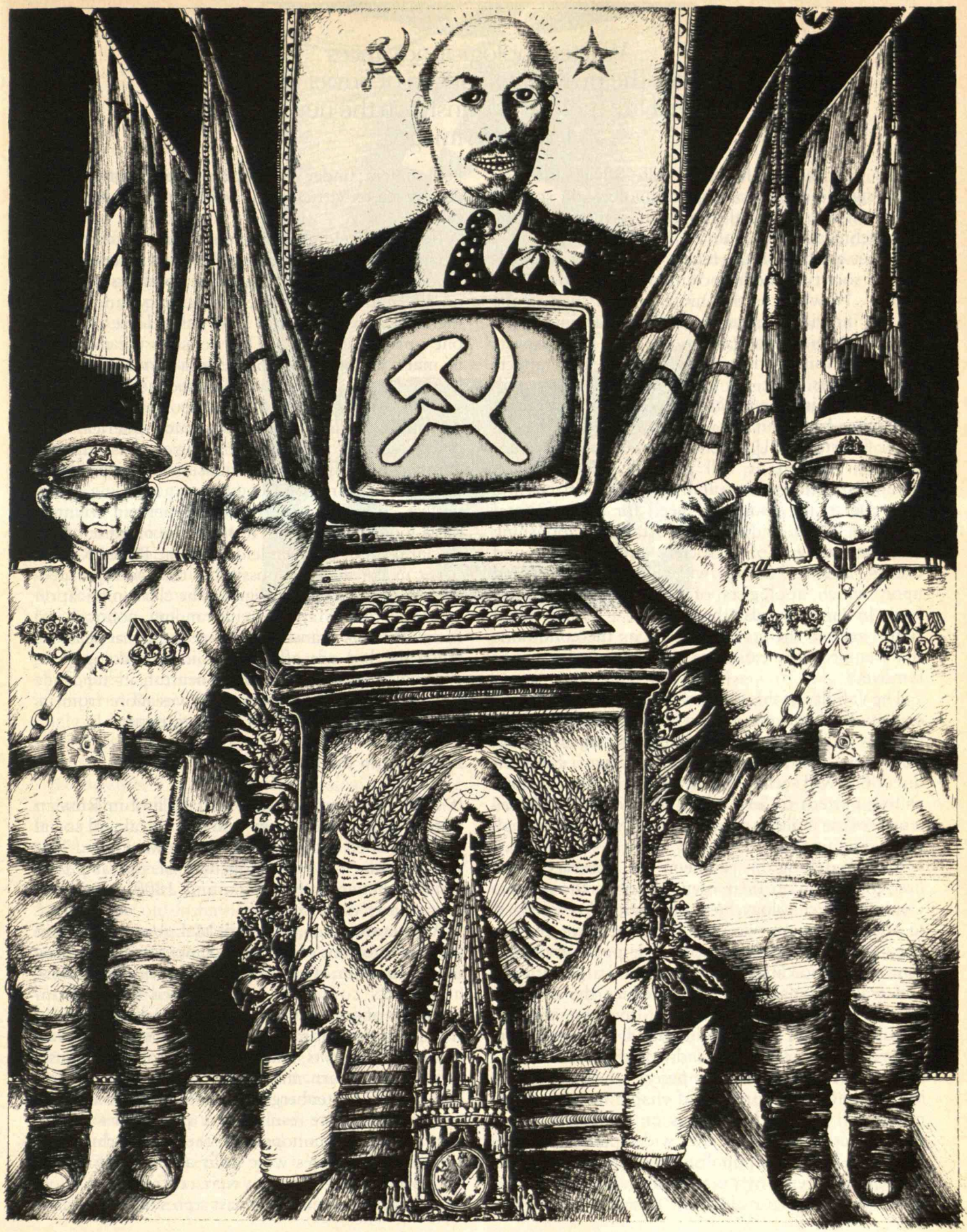
BY S. FREDERICK STARR

"History," Nikita Khrushchev once declared "is on our side." With this bold assertion, the Soviet premier affirmed the official belief that events within the USSR and around the world would inevitably unfold according to the prescriptions of Marx and Lenin. It was expected that capitalist systems abroad would collapse and that Soviet-type regimes would take their place. It was assumed also that something called "pure communism" would emerge within the Soviet Union itself.

Today, as every reader of the Western press knows, this hope was waned, as has the ideology from which it sprang. It is considered bad form in the Soviet Union to sprinkle one's speech too liberally with quotations from Communism's founding fathers; to do so is the sure mark of middle-brow upbringing. Even the recent Western enthusiasm for the less dogmatic early writings of Marx strikes no responsive chord among Soviet intellectuals. In the generation since Khrushchev, old ideals have faded while new ones have yet to appear. A country that fixed its eyes for half a century on a certain future now sees question marks.

For all the public disillusionment, the Communist party, at least, still clings to the old belief that history will eventually confirm Marxist theory. The party's tenacity on this point provides steady patronage for a small army of official intellectuals whose task is to save the old verities by translating them into modern terms. The goal of this group of Marxist theoreticians is to demonstrate that the so-called "scientific-technical revolution" (universally known in the Soviet Union by its Russian acronym NTR) will eventually transform world society along the lines predicted by Marx. Hundreds of books and articles on the "scientific-technical revolution" have appeared in the Soviet Union. These works, little studied in the West, contain the official Soviet view of the Brave New World.

The NTR literature presents a complex and in some respects extremely diverse picture. However, a common thread of deep conservatism unites all these works. Most of the authors dutifully acknowledge that the advent of high technology marks a "revolutionary" change in human affairs. Nevertheless, they see the information revolution, the modernization of smokestack industries, the integration of the world economy, and the concomitant changes in leadership and management as affirming existing directions of Soviet policy rather than changing



ILLUSTRATIONS: EUGENE YELCHIN

Will technological advances alter the prevailing pattern of Soviet life? Or will Soviet life mold and transform the new technology to its own image?

them. For most—albeit not all—Soviet theorists studying the impact of high technology on society, the "scientific-technical revolution" is more scientific and technical than revolutionary.

Soviet notions on the future of virtually every aspect of society reflect this cautious approach to technology. Nowhere is this more evident than in the area of individual freedom. Without pausing on the dissenting voices, one can observe three main aspects of the prevailing view of technology as it affects human rights. First, the age of high technology will finally establish the negative freedoms from hunger and other basic human needs enshrined in the Atlantic Charter, the U.N. Charter, and the Soviet Constitution. Second, it will gradually eliminate the social distinctions that still divide Soviet citizens and give rise to the continued need for governmental coercion. Third, and most important, by abolishing the last vestiges of a society organized around classes, high technology will eliminate the ground upon which apologists of "bourgeois" freedoms feed. In other words, the very ideal of individual rights *against* the state will fade as the conditions that required the existence of a coercive state are removed.

The validity of this prognosis cannot be confirmed or denied. However, one can identify areas in which the new technology is already influencing Soviet society and ask whether such changes have a common direction. Will technological advances alter the prevailing pattern of Soviet life? Or will Soviet life as it now exists mold and transform the new technology to its own image?

In approaching this problem, U.S. observers must first contend with their own biases on the matter. Computer technology has long been acknwoledged to affect society in two quite different ways. On the one hand, it affords unprecedented opportunities for centralized coordination and control. Large national and transnational data banks reduce the citizens' privacy and subject them to new forms of public and private scrutiny. On the other hand, computers can exert strong pressures for individuation and decentralization. As desk-top computers infuse new vitality into small enterprises and enable individuals to make well-informed decisions on important questions affecting their lives, they widen people's sphere of choice. Romantic populists take this possibility to its logical extreme by pointing to a day when computers will make possible new forms of consensual government, under which national plebiscites can be conducted on virtually any public issue within a few minutes.

Recent developments in the United States have encouraged those who stress the freedom-enhancing aspects of this technology. Such optimists see it as an alternative to coercive bureaucracy, and as the high road to efficiencies that will release time for one's private existence. They consider the computer to mark yet one more phase in a series of technological changes that emancipate the individual from social coercion. Like Soviet theoreticians of the "scientific-technical revolution," such Americans are convinced that the new technologies constitute the apotheosis of their society's basic values. But while the Soviet theorists see computers as leading to the perfect collective society, their American counterparts look to computers to fulfill the promise of the Declaration of Independence and the Bill of Rights.

Let us consider the possibility that both perspectives are valid to some degree. The clear implication would be that, Marx notwithstanding, political and social systems transform the economy at least as much as they are affected by it. Technology, according to this view, is fairly neutral; its tendency toward freedom or coercion derives more from its human context than from its inner nature.

Lesson from the Past

If this is so, one should expect to find in Russian history other instances in which political and social forces molded technology in their own image. This can be done. The introduction of movable-type printing between the 1550s and 1800 provides a particularly vivid example.

A generation ago, Marshall McLuhan argued that the very medium of printing democratized the flow of information. Thanks to Gutenberg's invention, new ideas could be disseminated freely from hundreds of points. As a result, each individual could command the information necessary to form his or her own judgments, without the mediation of priests or princes. In turn, the West was transformed.

In Russia, Gutenberg's epochal invention had precisely the opposite result. For a quarter of a millenium, the state monopolized the new technology. Virtually all presses were built and maintained by the government, and most were centralized in Moscow. Far from opening up vast stores of information

to the public at large, printing presses were used to disseminate standardized copies of such routine documents as laws and decrees. The function of printing in Muscovy and in early Imperial Russia was to centralize the production of information in order to render the tsarist state more homogeneous and efficient.

Strikingly absent from the products of the early Moscow printing houses were the new ideas of the era. Those, for the most part, were spread by the old-fashioned media of manuscripts and woodblock printing. Even the introduction of steam presses, which heralded the rise of a free and pluralistic public press in the West, served opposite ends in Imperial Russia. Whereas the first steam press in England belonged to the *Times* of London, the first such press in Russia was established by the Ministry of Internal Affairs.

To be sure, a more pluralistic system of printing eventually developed in nineteenth-century Russia. But as this occurred, the state moved rapidly to subject the technology to official control through censorship. As a result, many of the finest achievements of Russian letters continued to be disseminated first through the old-fashioned medium of manuscript. And with notable exceptions, the most modern print technology continued to be devoted mainly to publication of official documents and carefully censored works for the mass market.

The heart of the tsarist Russian political system was the primacy of the state. This principle infused virtually every aspect of Russian life, creating a system based on duties rather than on rights. All the major technological changes of the nineteenth and early twentieth centuries passed through this filter. The needs of the state defined the Russian rail network. The state became the largest consumer of steam engines. Telegraphy arose first in the military and then became a governmental function. And until recent years, internal-combustion engines were applied mainly to state-owned trucks as opposed to individually owned automobiles.

Automobiles and Individual Freedom

Surely, though, the mass production of Soviet-made Fiats heralds a change in this fundamental pattern. Do not private automobiles, by their very nature, help create new forms of individual freedom that were unknown a generation ago?

There is much to support this view, for the private automobile is undeniably an instrument of individual freedom. In the Soviet Union, it enables citizens to liberate themselves from regimented employer-sponsored group vacations. Instead of traveling as part of a *kollektiv* to some overorganized company spa, Soviet citizens who own automobiles can roam their nation's back roads alone or in intimate groups of family or friends. The automobile thus opens new horizons in the right of free association, enhancing freedom from state tutelage and the pervasive claims of society.

Automobiles also open vast fields for private entrepreneurship in the Soviet Union. Repair work, spare parts, accessories, and used-car sales all provide employment for thousands of hustling individuals. Differentials in the cost of such goods and services in various cities have enabled enterprising Soviet citizens to organize their private businesses on a national scale. For example, because automobiles are distributed without regard for regional variations in wealth, weather, and road conditions, people in the poor and underdeveloped North regularly earn money by selling the cars allocated to them to "dealers" in the prosperous and automobile-hungry Baltic.

Yet for every individuating aspect of the automotive revolution, there is a collective counterweight in the Soviet Union. Brochures published by the So-

The revolution of 1917 did not create Russia's distinctive political culture, but rather inherited it and built upon it.

viet automobile club sing the praises of vacationing by convoy in automobiles. Hostels, hotels, and motels give price breaks to groups, thus imposing a tax on the individual traveler. Collective control over vehicle maintenance extends to the most minute details: automobile owners who drive dirty cars are subject to fines. Checkpoints along major highways maintain the discipline of the state's internal passport system.

It is obvious, then, that anyone studying the Brave New World of Soviet high technology must do more than merely plot the steps by which a given innovation advances. The key variable is, rather, the web of policies by which the state seeks to confine the technology's impact to acceptable channels.

Computer Communism

One must approach the so-called computer revolution in this context. Between the Soviet computer industry centered in Byelorussia and the closely related Eastern European computer industry headquartered in the German Democratic Republic, the Soviet Union today has access to a broad range of hardware and software. Imports from Western Europe and Asia further extend the range of equipment available.

Major industries, such as the production of hydroelectric turbines, are heavily computerized. In the most advanced sectors, computers not only guide manufacturing processes but also monitor purchasing, inventory control, and bookkeeping. The State Planning Agency, which coordinates the entire Soviet economy, commands extensive computer resources not only at its Moscow headquarters but also at its branches in the various Soviet republics, all of which are linked closely with the center. Economists in major governmental enterprises regularly construct computerized models to assess policy options, much as their counterparts do in the West. The State Bank enters domestic and international transfers into its central computer network, which it then uses to plot trends and evaluate progress toward state-established goals. Even though the Soviet social security system operated entirely without benefit of computers until the early 1980s, advanced systems now operate in all of the highest-priority fields. Still more extensive is the application of computers to military needs.

Conspicuously absent from the list of Soviet enterprises using computers are those engaged in the so-called "second economy." This twilight realm of semilegal private enterprise, which deals in everything from garden produce to domestic services, now accounts for as much as 20 percent of the Soviet gross national product. Western Kremlinologists agree that the "second economy" is important to the Soviet economy as a whole. Nonetheless, this sector of the economy remains largely untouched by the computer revolution. If this continues, the unofficial private sector will gradually become a technological backwater, no matter how productive it may be. The negative implications of this for the future of individual freedom in the Soviet Union are obvious; entrepreneurship will dwindle steadily.

In contrast to the West, the computer in the Soviet Union remains overwhelmingly a producer good. Manufactured or imported by the state and for the state, computers have been used to render the existing governmental and administrative system more effective, not to change it. Far from broadening the sphere of pluralism and private choice, computers have emerged as the last best hope for making the old economy work. Created half a century ago by Stalin and now in a state of atrophy, this totally organized system seeks to gain a new lease on life through the scientific-technical revolution.

The Limits of Technological Change

Thus far, our analysis of the Soviet domestic situation leads to conclusions that support the validity of Khrushchev's boast. Provided that the Soviet government continues to dominate new technology, one can be sure that the "scientific-technical revolution" will serve the ends of existing policies. But might not other forces ameliorate the impact of the command economy on individual freedom in the Soviet Union?

The standard line of argument on this point among Western specialists on the Soviet Union is frankly apocalyptic. These observers hold that the centralized economy inherited from Stalin does not work, and that sooner or later it must be replaced by a system that permits more individual initiative. This notion, trumpeted by leading Kremlinologists, students of the Soviet economy, and newspaper columnists, contains a double fallacy.

On the one hand, it assumes that the Soviet economy is in more of a shambles than it actually is. With GNP in 1983 running 3.8 percent ahead of that of

the previous year, Soviet planners see little cause for despair. True, many goods are in pitifully short supply, and those that are produced are long on quantity and short on quality. Then, too, labor productivity has been falling at a time when the country faces a labor shortage of major proportions. Yet the quality of life for most Soviet citizens has improved over the past generation. Salaries earned by members of the intelligentsia have stagnated, but factory wages have increased steadily, at least until recently. And all this has occurred at a time when the nation has chosen to invest staggering sums in the military. Such considerations leave most Soviet leaders convinced that, while certain changes are desirable and necessary, "the system" itself is fundamentally sound.

Even if this were not the case, there is reason to doubt that fundamental changes would be forthcoming. The universal human desire to preserve domestic tranquility, the absence of a shared sense of economic crisis, and the pride that comes from the knowledge that one's nation is a superpower all serve to protect the status quo. Erosion is far more likely than explosion. Barring a sudden and dramatic downturn, the Soviet Union will continue to muddle through.

Assuming, then, that the new technology need not enhance civic freedoms in the Soviet Union, are there no other forces for positive change in that country? Is Russia in 1984 fated to pursue a course of development that will push it further toward George Orwell's nightmarish vision of a world totally devoid of individual freedom?

Conformist Peasants and Individualistic Urbanites

The central point upon which any answer to this question must turn is Russia's distinctive political culture. Based on the primacy of the collective identity over that of the individual, the culture as a whole reinforces the communist system that shapes daily life. The revolution of 1917 did not create this culture but rather inherited it and built upon it. The system's roots must be sought deep in the Russian past, and specifically in the world of the Russian peasantry.

Rural Russia was never dotted with private farmsteads of the kind that produced the "hardy individualists" of New England. Instead, groups of families lived together in village communes and worked the land collectively. Not only did these families labor as a group; they paid taxes and served in the army as a group. Undergirding communal life was serfdom, an authoritarian though remote state, and a form of Orthodox Christianity that exalted the collective over the individual. Communal values were also reinforced by the patriarchal family, and by the fact that young peasants passed directly from childhood to adulthood, with no period of youthful independence and experimentation in between.

When members of the village commune had to make decisions about planning or harvesting, they did so through Quaker-type consensus. When people could not agree, as often happened, the "elder" simply laid down the law. His decision was final, and anyone disagreeing with it was expected to fall into line. Submissiveness and conformity were part of the system, as was endurance, for the life of the Russian peasant was hard.

Collective agriculture shaped peasant Russia's attitude toward deviance. Dissident elements were suppressed or, failing that, banished from the village. Alexander Solzhenitsyn's exile to Vermont is a recent example of this age-old practice at the national level. The goal of such actions was to defend the collective from dangers, real or imagined. In addition to protecting itself against internal rebels and dissidents, the communal village had also to be on guard against

Soviet families have been altered almost beyond recognition. Differences in education between fathers and children erode the authority of the traditional *pater familias.*

external threats from landlords, the government, and do-gooders. All were treated with the same combination of suspicion, cunning, and outright hostility.

Formed over many centuries, the outlook of the Russian peasant handily survived the various agrarian reforms introduced before and after the Bolshevik Revolution of 1917. Stalin's forceful reorganization of agriculture in the years 1929 to 1932 left millions of peasants dead, but in the end buttressed the peasant mentality by once more binding the rural populus to collective farms.

Against this background, the recent tide of people choosing to move out of collectivized agriculture and into the cities is nothing short of a revolution. This change, as important as any that has occurred in Russia over the past millenium, is documented by recent Soviet censuses. As late as 1950, two-thirds of the Soviet population was rural. Today, that proportion has dropped to less than one-third and is still falling. Over one and a half million people have fled the farm each year for a decade. Those who have immigrated to the cites are overwhelmingly young, talented, and ambitious. Rural Russia today is inhabited by the elderly and the also-rans, along with a small but growing group of Soviet-style agro-industrialists who have as little sympathy for traditional peasant life as those who left for the cities.

The death of peasant Russia has, in one stroke, severed the link binding Soviet society to rural life that nurtured the Russian collectivist mentality for centuries. Collective farms still exist, to be sure, but they are no longer schools of communism or of anything else.

Cautious Soviet leaders have long hoped that village conformity and discipline could somehow be retained in the cities. But modern cities impose their own values, and these are rapidly transforming the outlook of Russia's former peasants. Urban life in the present-day USSR, no less than that elsewhere in the world, means large apartment complexes, individualization, fragmentation. It also means education, access to more sources of information, and relative freedom from parental authority and tradition. It means the freedom to change jobs, which one-fifth of the labor force exercises each year. Instead of endurance and suffering, it means the hope of gratifying one's ambitions and desires. Finally, it means youth and the entire culture of the young that characterizes the modern world from Seattle to Budapest to Tokyo.

It would be vain to think that the mentality of peasant Russia will vanish overnight. Until recently, this value system was still passed down to urban children by peasant grandmothers brought in from the countryside to look after the children of upwardly mobile working parents. But the move to the city is exposing millions of younger Soviet citizens to a world where people jockey for power in their offices, pore over reports translated from foreign journals, make deals to get Scandanavian furniture for their apartments, and pull strings to get their children into selective schools.

Does this mean that Russia's population is about to "converge" with that of the United States and other Western industrialized countries? That seems unlikely. The communist economic system and authoritarian political regime remain fundamentally different from ours. Yet the psychological distance between the populations of the Soviet Union and those of Western Europe and the United States is definitely narrowing, as the Russian people shift to an urban and more Western way of life. The aspirations and worries of the new Soviet urbanites are far closer to those of their counterparts in the United States than to those of anyone in their own rural past. One can scarcely imagine a bearded Russian peasant spicing his speech with talk of "best-sellers," "weekends," "hyping," and "communication gaps." Yet these concerns are all debated in Soviet newspapers and magazines today.

These new social conditions are the essential preconditions for any future changes in the status of human rights in the Soviet Union. Their impact is gradual but pervasive. They form what Alexis de Tocqueville called "a kind of intellectual atmosphere in which both governed and governors move and from which they draw the principles of their conduct, often without realizing it."

The Rise of Solo Personalities

What evidence is there that a new intellectual atmosphere is actually emerging? Given the speed with which urbanization has occurred, one should look for evidence of the new mentality particularly among the under-30s who form the majority of the population. The fact that members of this group have lived their entire lives in the post-Stalin era sets them off from their elders. The measure of the change can be found in the sheer extent of intergenerational

Baton Passes to Spring Teams

David Schultz, '87 (left), and Brian Callaghan, '87, were among the members of 14 winter varsity teams that racked up a season score of 153 wins and 83 losses. All-American honors went to four members of the swimming and diving team. The 12 spring varsity teams headed into 93 contests in April. (Photo: S. Wheatman; '86.)

MIT

MAY/JUNE 1984

A Musician's Tribute to John Corley

Student View/Diana ben-Aaron

Diana ben-Aaron, '85, is majoring in humanities and materials science. Her "Student View" appears regularly in this space, and she is also serving as features editor for Volume 104 of *The Tech*.

When John Corley decided to come to M.I.T., back in 1948, his image of music at the Institute was banjos, because one of the first alumni he ever met, Albert C. Sherman, Jr., '14, told him that the Tech Banjo Club was big on campus when Sherman was here.

Of course any such singular view of music here is (and was even in 1914) wrong. And since 1948 Corley has had a large part in making it so. There is today music in every form played every day here—from medieval to electronic, symphonic to vocal. But John Corley is the senior in service of M.I.T.'s music teachers, and no one who has played for him in the Concert Band can fail to have been changed by the experience. For literally hundreds of alumni since 1948 "music at M.I.T." must mean the Concert Band.

"They're Thinking . . . All the Time"

As a conductor, John Corley walks the fine line between ineffectiveness and tyranny with consummate skill. His secret? Fierce concentration. His mind never wanders from his goal of helping the band make good music. Not a second is wasted during the Concert Band's two-hour rehearsals.

His musicians match his intensity. "There's no group I'd rather go in unprepared with than M.I.T. students," Corley has said, "because they're thinking, thinking all the time."

In his spare time, Corley casts himself in the role of a student studying the scores, consulting composers when possible. He even plays student in rehearsals, asking for repetitions not because a passage is poorly performed but because "I hear something I didn't hear before."

"Make it sparkle, like breadsticks and ginger ale . . . That run should squeak like a fingernail on a blackboard."

But his principal job as conductor is to bring the insights of his studies to bear on the band's performance with stunning metaphor, hyperbole, and even warning: "Make it sparkle, like breadsticks and ginger ale. . . . That run should squeak like a fingernail on a blackboard. . . . And now for my favorite two measures in all band music. Those are the most important four notes you'll play all year." And of the Holst suites and Percy Grainger marches from the more classical band repertoire: "Don't even take these pieces for granted."

One piece starts with a long note played by the clarinets. John says, "Can you warm it up some?" and then puts down his baton and folds his hands over his stomach, which means he is going to tell a story. "A friend of mine, a composer, came to hear this group once," he says. "And he said from the first note he could tell that the M.I.T. Concert Band was a very close, caring group. So many bands are just dull."

Then he picks up his baton and begins to conduct again. Who could be unaffected by praise like that? The opening note swells into Kresge Auditorium, raising the temperature of the hall about 5 degrees.

"When I hear other groups, I really miss the kind of music we play," John says. "I went to Symphony Hall the other night and I almost fell asleep, it was so dull! They were playing good music, but it was 'all on the white keys.' The accidentals are what make it interesting."

Knowing When to Keep Quiet

This M.I.T. band was one of the first two groups in the country to devote itself exclusively to works written for concert band; since December 1953, it has eschewed marching band literature and transcriptions of any kind. As a result most new band members have never heard—much less played—anything

Continued on page A25

MIT

MAY/JUNE 1984

Letters

In This Issue

The Risks and Gains of Studying Abroad A4
. . . including reports by two undergraduates who did it (in Kenya and China)

McNair and Lichtenberg on Life Aboard the Space Shuttle A8

Why Drama at M.I.T.? A14
"Perspective . . . awareness . . . self-knowledge," says Scanlon

Under the Domes A10

Course News A18

Obituaries A26

Puzzle Corner A29

Corrections

Two items in these pages for February/March require comment:

☐ The photograph published in connection with our tribute to the late Henry G. Steinbrenner, '27 (*page A28*), is by error of Mr. Steinbrenner's son, George. The confusion arose because both were participants in the dedication in 1978 of the Steinbrenner Stadium at M.I.T.—a poor reward indeed for the generosity of George to his father's alma mater. We apologize to readers—including especially the Steinbrenner family.

☐ Alumni of the Sloan Fellowship Program have taken exception to the characterization of Sloans returning for their convocation in October as "contentious, disrespectful brats" (*page A12*). The headline was conceived an an overstatement so extreme as to assure disbelief, and the editor regrets that it was open to any other interpretation.

When Words Are Inadequate

In "The Magic of Edgerton" (*January, pp. A6-A9*), Pepper White provides a significant but by no means adequate tribute to Professor Harold E. Edgerton. The inadequacy lies not with White's reporting or storytelling techniques, however—they were superb. Rather, I refer to the deficiency of written language when confronted with the task of describing experiences with greatness. I, too, have experienced much of what White describes, and I can testify that Doc's magic extends far beyond mere mortal words. All attempts at appraising Edgerton's qualities should be footnoted with a disclaimer concerning the effort to accomplish the impossible. "The Magic of Edgerton" must be experienced first hand to be fully understood.
Adam Brody, '85 *Cambridge, Mass.*

Alpha Phi Not the First

Though you refer to Alpha Phi as M.I.T.'s first sorority (*February/March, p. A24*), the fact is that Alpha Kappa Alpha, the oldest black national sorority, chartered its Lamdba Alpha Chapter at M.I.T. on October 8, 1977. Since then, new members have been pledged into the chapter annually during the spring. Alpha Kappa is a community service sorority dedicated to "service to all mankind," in contrast to Alpha Phi, which is a social sorority.
Leslye M. Fraser, '78
Long Beach, Calif.

Infringement of Liberty

The concept of "individual youth services" put forth by David S. Saxon, '41, as a generalization of the military draft (*see February/March, p. 86*) seems attractive to some who are uncomfortable with the idea of military service, since it provides a way to make alternative work seem equivalent. This, however, is precisely why I am opposed to it.

In my view, the military draft is an infringement of individual liberties and an interference in the economy that is justified only to the extent that military service is *different* from other work—in particular, that it is essential to the defense of the nation and there is no other practical way to raise the necessary forces. This justification cannot be carried over into normal, non-emergency work. To the extent that military service is like other work, we already have a system that recognizes that equivalence—namely, the All-Volunteer Force.
Joseph W. Dehn III, '75
West Haven, Conn.

Dr. Saxon replies:
I have urged only that serious study be given, through a congressionally-mandated select commission, to the potential of a program of universal youth service combined with an analogous universal "GI Bill" for education. Despite my obvious enthusiasm for what I believe would be the potential benefits of this kind of plan, it must not be assumed that I view a study of the idea as a pre-programmed prelude to its implementaton. I have by no means thought through all the ramifications—both beneficial and, perhaps, hurtful—of the proposal. That is what the work of the select study commisssion would do, and that is what I have proposed.

Engineers and Real Estate

The new Center for Real Estate Development (*February/March, p. A16*) is long past due. When I graduated I stumbled by "accident" into the field because of economic conditions, and my experience suggests that the field is an interesting one for an engineer. Real estate development requires a knowledge of all phases of construction, electrical engineering, heating, air conditioning, mechanical engineering, and electronics. Equally important is a knowledge of business management, accounting, real estate law, government regulation, labor relations, and diplomacy (in handling tenants).

I suggest that the scope of the center be expanded to include management.
Paul J. Petitmermet, '33
La Jolla, Calif.

All For Rush Week

Contrary to the views of Ira J. Goldberg, '71 (*February/March, p. A3*), I believe that residence rush week at the beginning of the year is one of the best things M.I.T. does for freshmen. It gives them a chance to review housing choices and select where they will live, rather than being assigned to a dormitory they know nothing about. I hope no one has any plans for dismantling the system.
Christopher P. Hamkins, '80
Charlottesville, Va.

Foreign Study Can Be Cheaper (and Better) Than Staying Home

Bad break

By Sue Lewis

I think of it as an underground program," says an administrator who is close to it.

It is governed by a self-screening process that only the tenacious and exceptionally capable survive.

And as far as anybody knows, it has a zero failure rate.

It is the "Junior Year Abroad" program, described on page 45 of the catalog, where students are assured that those who take an approved one-year program overseas maintain their M.I.T. registration and aid, receive at 90 least units of credit, and may well find their costs less than those for a year in Cambridge.

But the catalog does not begin to tell the whole story. For starters: participants rarely elect to take a whole year, and they are not restricted to their junior years. And only an average of 35 undergraduates go abroad annually on the official "junior year abroad" arrangements, while an uncertain number that may be at least as large interrupt their M.I.T. studies to go overseas on their own initiative.

When Professor John T. Norton, '18, set up a program for international study in 1956 the year after he retired from 44 years of teaching physics and metallurgy, it was conceived as a full year during which students would use their overseas experience to complete humanities requirements, learn a language, and perhaps to start on a thesis. But Professor Norton recalls that the idea was slow to catch on (it "never amounted to much," he says) because M.I.T. students regarded it as "time out" from their treks toward professional degrees and good jobs.

Numbers Belie Impact

The idea of overseas study is still not very popular when measured in numbers, but it's far more successful and important than Professor Norton realizes, says Robert K. Weatherall, director of career services and preprofessional advising under whose wing international study now finds modest accommodation.

Weatherall and his assistant Marie Oommen try to be the central collecting point where all undergraduates going abroad check in at least once, and usually several times. They try to help students clarify their thinking. What are their objectives in going abroad? What countries are they interested in? What languages do they speak—would they like to learn? What credits do they have at M.I.T., and what courses can they take overseas? And how hard are they willing to work to set up an international experience?

Some students, like Joseph Cerami, '86, know exactly what they want to do. Cerami had dreamed about going abroad since his high school days in the AFS (American Field Service) Club in his high school. He also knew he wanted to minimize the hassles with language, so that meant going to Britain. He started looking for ideas in his freshman year, and soon enough one of his teachers in chemical engineering had convinced him that University of London's Imperial College of Science and Technology was the answer to his dream.

The ultimate organizer, Cerami started laying plans at once. He accelerated his courses and succeeded in "doing OK" with an overload, so his way is cleared to spend all of next year in London. He'll be studying chemical engineering—not exactly "time out."

Other students, like Phillip Tietbohl, '85, begin the process with much less developed objectives. For him, it was simply a determination to capitalize on his background in German. With help from Oommen and several faculty advisers, Tietbohl chose a well-travelled track—the Institute for European Studies in Vienna, one of many outposts of IES.

Oommen, language teachers, faculty advisers and fellow students have stockpiled a wealth of information on what is available in Europe. But it's not all in one place; students like Tietbohl must dig it up.

Once a student designs a program, it must be reviewed by Oommen's office and by the student's academic department. Since almost every M.I.T. student abroad is working on humanities credits, programs also have to be checked by Ruth Spears, coordinator of the Humanities Undergraduate Office, to assure transfer credits when the globe-trotter returns.

Freedom to Change

But all this planning effort may be only theoretical after all, Spears explains. There are lots of possible problems after a student arrives in Trondheim, Zurich, or Nairobi. Courses turn out not to be available, professors are away, a course is too difficult/too easy, the brochure was misleading, or there is simply something much better available. M.I.T. leaves students free to change their whole programs on the spot.

And Lisa Granick, '84, did just that. The agency which organized her "Scandanavian seminar" operated on the premise that North Americans were not qualified to take university courses in Norwegian. So participants were enrolled in a variety of "folk schools" that offered a mixed bag of craft and academic courses. But that wasn't quite what Granick had in mind.

Her facility in languages honed on German, French, Russian, and Latin, Granick quickly progressed in Norwegian. Restless in the Folk School, she tapped all her contacts in Norway and gained the impossible—admission to the Norwegian Institute of Technology in Trondheim. That led ultimately to a 20-week internship in heavy industry

during which—among other things—she operated the crane that emptied the crucibles of molten metal. (That particular skill was a surprise to everyone: she snatched the controls from the hands of a disoriented fellow worker, thus at once averting a serious accident and learning a practical lesson in the high cost of poor management.)

None of the above was covered by her approved plan, but all of it was easily parlayed into a full year of M.I.T. credits when Granick returned. Indeed, Ruth Spear says she has never known a student to fail a course abroad or to fail to receive adequate M.I.T. credit.

Financial Aid Portable

Another eye that scrutinizes the programs of students bound abroad belongs to Dorothy Bowe, associate director of student financial aid. Thanks to administrative procedures Bowe helped put in place, students abroad on an approved program can take their financial aid with them, using scholarships and loans just as they would at M.I.T. Weatherall considers that privilege "crucial" to the program of international studies.

What do the students bring back from all this? Experience of a totally different intellectual climate, emphasizes Weatherall, where the discussions in the classroom blend easily into the discussions in the pub, and where often the "very stones around them speak of history and culture."

A rich storehouse of mental language, a clearer idea of the impact of technological excellence in the world, and an understanding of what is really distinctive about American institutions, stresses Oommens.

For Tom Ransohoff, '84, the experience of a year in a University of Syracuse program of study at Strassbourg led to a big change in the direction of his career as a chemical engineer. In Strassbourg he was deeply influenced by a French political science course, and he now wants to apply his technical skills with an international agency such as the World Health Organization that needs chemical engineers to help provide safe water supplies worldwide.

Douglas Heath, '81, says his combined program of language study, business education and working in Germany, solidified his command of German and helped him get into Harvard Business School, where he is studying now. But it did not point him toward an overseas career; quite the opposite. Heath concluded that he's unlikely to achieve his goals as a manager if he tries to work in a language other than English, and—in any event—he really is culturally more comfortable at home.

In some ways Phillip Tietbohl's experience in Vienna, which included studying, traveling, meeting villagers and students, and visiting the Eastern Bloc, actually made his life more difficult. About to receive his degree in mechanical engineering and hard at work on his thesis project in robotics, Tietbohl is a passionate proselytizer for overseas study. He has three job offers from solid American companies. He also has applied to work or study in just about every program or avenue for international opportunity that M.I.T. has to offer. The rub is that he must decide about the jobs before he will know the outcome of his international inquiries.

Is a job in the hand worth several slices of pie in the sky? At what point is one supposed to "get serious" and get a job? And is it realistic to think he can always opt later for study or work abroad, after he has worked for a few years here?

"It's a Rare Student Who Can Cope"

Professor Robert L. Halfman, '44, whose many hats include that of associate dean for student assistance services, has to put his stamp of approval on all overseas programs. He admits that the idea of foreign study has a small constituency and limited support at M.I.T. But he's not surprised or concerned. In his view, "the pressures of getting through M.I.T. are such that very few students . . . can afford the luxury of

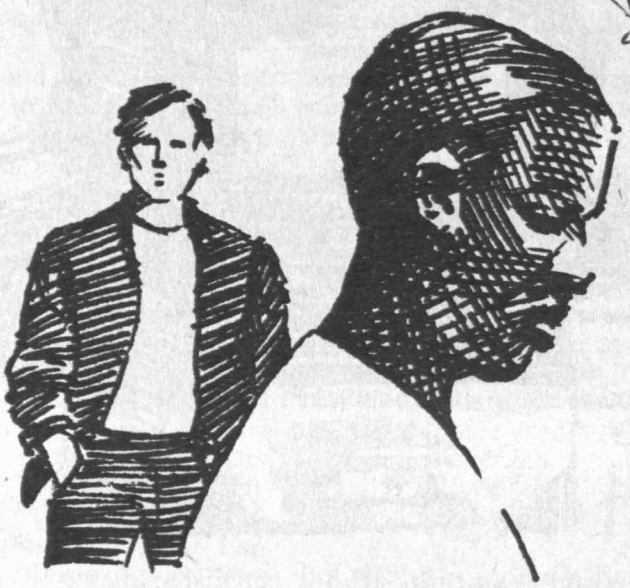
ILLUSTRATIONS: KATHERINE MAHONEY

reordering the curriculum."

"They screen themselves," Dean Halfman says, "and the process produces a couple of dozen excellent candidates every year. . . ."

No wonder, then, that the M.I.T. students who tackle foreign study are welcomed by institutions abroad. Some foreign schools, such as the London School of Economics and the University of Aberdeen, send faculty members to promote their programs among M.I.T. undergraduates and graduate students.

And when the time comes to seek a job, experience abroad is regarded as an asset by prospective employers, Oommen reports. She finds industry looking at the whole person, beyond courses and grades, and quick to value the wisdom that overseas experience can give a prospective employee. □



Student Tastes Minority Experience

Kenya a Real "Education"

by Roy Steiner

Roy Steiner, '85, of London, Ont., Canada, spent part of his junior year abroad and wrote this report as a letter to the editor of The Tech, *from which it is reprinted by permission.*

It was in the fall of 1982 that I stepped off a 747 onto African soil to spend a junior semester abroad in Kenya and Uganda. It was the first time in my life that I had ever been a minority. This situation was intimidating at times, and I'm not sure I ever really transcended it.

The differences between my culture and theirs were very real, and I found myself seeking out the company of my fellow Americans. As I did this I started to understand why minorities at M.I.T. have a tendency to stick together. It's natural human feeling to be with people who are like yourself and with whom you can truly communicate.

The problem I had with this feeling was that I could never really experience Africa until I broke my self-made bubble and ventured out into the unknown. It's really hard to break down those barriers of race, culture, and education—sometimes it's impossible. However, I found that when my efforts were sincere a whole world of human relationships opened up to me. By limiting our interactions to only people who are like us we inhibit our ability to grow as human beings.

I remember coming back to the States and noticing a tremendous number of misconceptions and prejudices, ranging from the blatant to the very subtle. Recently, an interracial couple who are good friends of mine were walking down Massachusetts Avenue when they had a beer bottle hurled and several racial slurs called to them from a passing car. Obviously, most prejudice is not this overt, but shortly thereafter I remember having an extremely heated discussion with a friend about whether racism was a problem in the United States. I couldn't believe someone could insist that prejudice was not a problem when he had never talked to a person of color.

All of us at M.I.T. have unlimited opportunities to learn what other people are all about, yet most of us rarely do. By not doing so, we are hindering ourselves from becoming loving human beings. I guess the problem is that remaining the way we are is very easy while changing ourselves always takes effort and is often very uncomfortable. To solve the problem of prejudice requires a fundamental change in our attitudes towards other human beings. If this solution could be attained, I think most of our other problems would also be solved. □

Questions About China—and About Self

By Gloria Lee, '83

Gloria Lee, '83, came to M.I.T. in 1978 expecting to go on to law school. But after two years that somehow didn't seem to be so appealing, and Gloria decided to make a radical change in her life: spend a year in China, where her parents were born.

It worked. Back at M.I.T. in 1981, Gloria changed her major to political science. Now she wants to try for a writing career—and perhaps soon for graduate work in anthropology or history. Here's the story of that "unofficial" junior-year-abroad programmed by Gloria for herself, in contrast to the "official" programs described in the accompanying article (pages A4-A5).

The establishment of diplomatic relations between the U.S. and the People's Republic in 1979 allowed American students to go to China for the first time in many years, and it was a chance I couldn't resist. My year with the first group of American students was spend in Beijing, studying Chinese at an international institute and simply meeting people—Chinese people as well as my fellow students from Africa, Europe, North America, and Asia.

"Meeting the Chinese" was hard to do in 1979. The country still felt the chill left by the Gang of Four: there were many restrictions, and people were haunted by the feeling of being watched. As a Chinese-American, the restrictions on me were a little lighter than on most visitors, and I could move somewhat freely in and out of Chinese neighborhoods. I spent weekends in the homes of Chinese relatives and friends around Beijing.

You couldn't get away from M.I.T., even on the other side of the world. M.I.T. was on the lips of Chinese students who aspired to study abroad. M.I.T. was included in an English-Chinese dictionary published in Beijing. I even ran into a recent M.I.T. graduate who was taking some time away from his California graduate school to study Chinese and look for geological research opportunities in China.

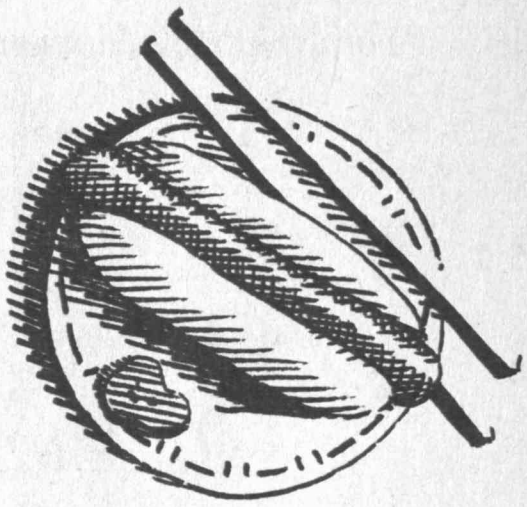
I studied Mandarin, literature, and a little bit of history; but mainly I just observed—the ghettos of foreigners, the tight-lipped behavior of Chinese friends and relatives, the restricted bookstores into which, if I dressed and walked with care, I entered freely. I cycled about the city and roamed the small hu-tong [alleyways]. I watched a trial of bicycle thieves. I read Orwell's *1984* and Zamyatin's *We*, I listened to the news of China's plans for industrialization, and I wondered about the dark blue and grey masses of people in the city.

In the spring of 1980, colors reappeared in the form of potted plants and bright adult clothing. Advertisements for TDK tapes began to compete for billboard space with bright red sayings of Chairman Mao. The liu-mang ["hooligans"] were making a scene with their "Made in Hong Kong" stickers still fixed to the lenses of their dark sunglasses. Imported disco music could be heard at the Summer Palace and in public parks. The first "free markets," markets for private profit, were open, filled with live chickens, eggs, and strings of garlic. The popsicle vendors, elderly women with white caps and aprons, were back on the streets, pushing their carts.

And through the watching and listening, I wondered what was "right" for China, what was the "proper" way for this new socialist country to industrialize. Some of the foreign students in Beijing hoped that China, the new experiment, would be intelligent—that there would be strong anti-pollution laws, or that nuclear power would not be utilized as an energy source. Others were concerned about the roll of women in China, hoping that Chinese women had really obtained equality in the socialist society. People began assessing China with their own cultural yardsticks, but their thinking was confounded by undefined terms and unexpressed beliefs.

Would China learn from the West, accepting Western things as "good," "advanced," and "right" for China? Or would some syncretic path be achieved? How would these changes mesh with the political theories that were the basis of the revolution? And what of the government, and the revolution: was it merely a change of dynasty, as some foreigners had remarked?

When I returned to M.I.T. I changed my major to political science in order to study the nature of social change, the influence that the belief in science and industrialization has on the course of change in a non-Western society, and the cultural assumptions that lie beneath these beliefs. □



"You couldn't get away from M.I.T., even on the other side of the world. M.I.T. was on the lips of the Chinese students who aspired to study abroad. M.I.T. was included in an English-Chinese dictionary. . . . I even ran into a recent M.I.T. graduate looking for geological research opportunities in China."

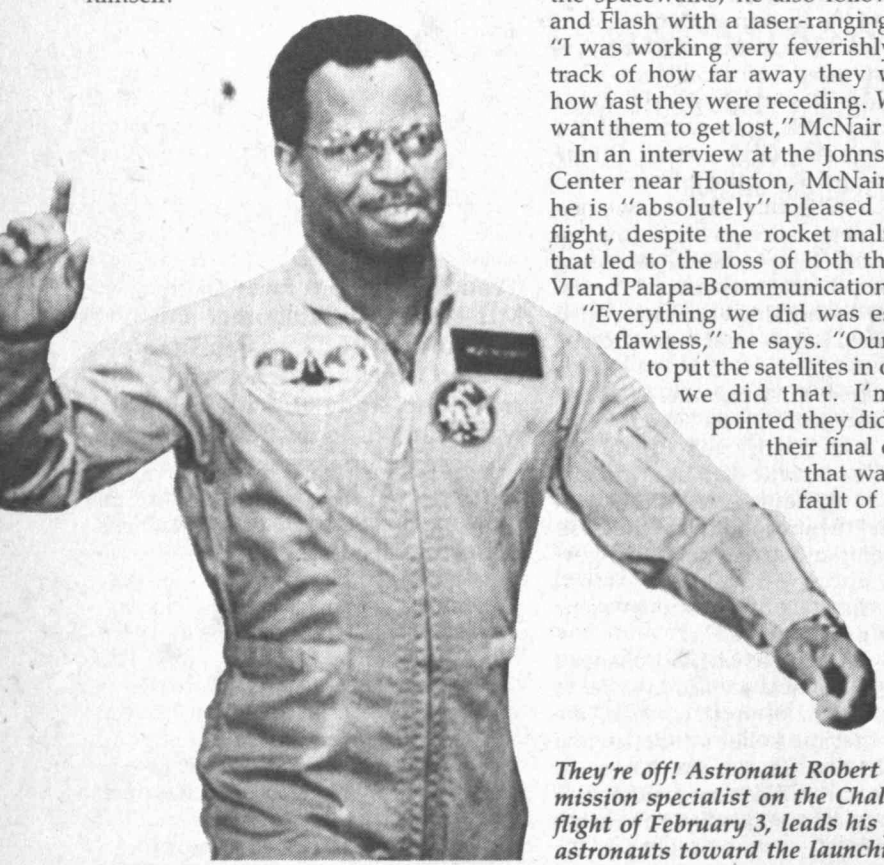
McNair: No Words for What Happens in Space

For a Fleeting Moment He Was the Cecil B. De Mille of Mission 41-B

By Damond Benningfield

Outside the space shuttle Challenger, astronauts Bruce McCandless and Robert Stewart—Buck Rogers and Flash Gorden to the admiring television audience—were buzzing around their orbiting home, putting jet-powered backpacks through a series of rigorous tests.

Inside Challenger's crammed flight deck, things were even busier. While commander Vance Brand and pilot Robert Gibson kept an eye on the ship, Robert "Cecil B." McNair, Ph.D.'76, brought the spectacle of the first untethered space walk to the world live and in color. His battery of television cameras—some inside the cabin, some in the shuttle's cargo bay, and others on the mechanical arm—kept McNair so busy he barely had time to enjoy the view himself.



AP/WIDE WORLD

They're off! Astronaut Robert McNair, mission specialist on the Challenger flight of February 3, leads his fellow-astronauts toward the launching pad.

"I had more cameras than you could ever imagine," he says. "You would not believe how busy things got with all those cameras. . . . That's one thing the simulators just couldn't prepare you for."

McNair was a mission specialist on this shuttle flight 41-B last February. He was the second M.I.T. graduate to fly in as many shuttle missions—Bryon Lichtenberg, Sc.D.'79, (*see page A9*) was a payload specialist with Spacelab 1 late last year.

Television producer/director/cameraman was only a part of McNair's job during the busy eight-day mission. He also was in charge of deploying the two ill-fated communications satellites, manipulated the robot arm, and operated a series of scientific experiments. During the spacewalks, he also followed Buck and Flash with a laser-ranging system. "I was working very feverishly to keep track of how far away they were and how fast they were receding. We didn't want them to get lost," McNair explains.

In an interview at the Johnson Space Center near Houston, McNair told me he is "absolutely" pleased with his flight, despite the rocket malfunctions that led to the loss of both the Westar VI and Palapa-B communication satellites. "Everything we did was essentially flawless," he says. "Our job was to put the satellites in orbit, and we did that. I'm disappointed they didn't reach their final orbit, but that was not the fault of the shuttle or the crew."

A Dream Come True

After completing his Ph.D., McNair joined the Hughes Research Laboratories in Malibu, Calif., to work on the development of new low-temperature (cryogenic) lasers. It was there that McNair saw a NASA announcement asking for astronaut applications. It was 1977, and the space agency wanted to bolster the depleted astronaut corps with new blood for the space shuttle program. In particular, it wanted mission specialists to deploy satellites and operate experiments.

"I had thought about being an astronaut in the past, but only the way a kid dreams after seeing moon shots," McNair says. But when he saw the announcement, McNair decided he really *was* interested, applied for the job, and was selected as an astronaut candidate in 1978. He became an astronaut a year later, after a rigorous training and evaluation process.

Before he was assigned to mission 41-B, McNair bounced from assignment to assignment in the astronaut office. When the assignment to mission 41-B came along, he turned to laser instruments and the other tasks of that flight.

With mission 41-B complete, including a couple of weeks of technical debriefings, McNair and other crew members were dispatched on a good will tour of the country. Then it was back to Houston for another assignment and another flight: "I don't have another one yet, but I check the board every day," he told me.

McNair says the thrills and sensations of space flight are impossible to duplicate on earth. At a "welcome home" ceremony on the Kennedy Space Center runway after touchdown, McNair told friends and workers that, "We had a great time . . . I wish words existed that could describe it. I might have to invent some."

DAMOND BENNINGFIELD is a free-lance writer with extensive experience covering NASA and the Johnson Space Center.

"It's Very Difficult to Make a Peanut-Butter-and-Jelly Sandwich in Space"

How Byron Lichtenberg Remembers Skylab I

NASA

Byron K. Lichtenberg, Sc.D. '79, payload specialist on the first mission of Spacelab carried by the Space Shuttle last December, poses during training in a mock-up.

Byron K. Lichtenberg, Sc.D.'79 Aero & Astro, a biomedical engineer in the Department of Aeronautics and Astronautics' Man-Vehicle Laboratory, was the first payload specialist to fly on the space shuttle. Here are some of his recollections of the seven days in space last December, as recounted for D.C. Denison in the Boston Sunday Globe *(March 4—reprinted by permission).*

Q. How long did it take to prepare for the flight?
A. It took over five years. We were selected in June '78, started training the following October, and have been going pretty much ever since. For the first four years we spent most of our time going to the scientific laboratories, working with the equipment, and learing how to do the experiments. And then during the last year we came back to the fold at NASA and began training with simulators and actual flight hardware.

Q. After all the simulations, were there still surprises once you got up in space?
A. There was only one thing that really surprised us, and that was a thermal shock that we experienced about three or four days into the mission. We had been flying an orbit with our tail toward the sun, so we were fairly cold, and then we turned abruptly so that the whole payload bay was facing into the sun. Apparently it warmed up rapidly, because several hours later I was working at one of the computer keyboards when all of a sudden we heard this strong *thud*. My feet were in footloops on the floor, and it felt like the floorboards actually lifted up.

Q. Did you think it was a meteor?
A. That went through my mind. For about 10 seconds the heart stopped. Everybody looked, listened, but there were no alarms. Then we all started saying, "We're still here, so we must be okay." We checked everything, and there weren't any other sounds, which is what you listen for. The pilot checked every one of his 30 or 40 computers. Then we started hearing more [thuds], so we figured the metal was just warming up, which makes sense because it's just 34,000 pounds of tin can. But that was something no one had reported before.

Q. When you were up there, was there anything earthly that you really missed?
A. Yes. Eating is not as much fun in space as it is on earth. All of us ate with just one utensil, a spoon, and because you couldn't let anything go, you ended up eating all of one thing, one packet at a time, and then all of another packet. We did a lot of snacking. We tried to make sandwiches, but that wasn't quite as successful as we had envisioned. It's very difficult to make a peanut-butter-and-jelly sandwich in space. Making a sliced-beef-and-cheese spread was a little easier—you just get everything out and floating, and then sort of clump it together.

Peanuts were the most fun to eat. At first I opened the bag and tried to just pour them into my mouth, but that didn't work. Then I pulled the bag down, but all the peanuts stayed where they were, so that now there were 20 peanuts floating around inside the module. I had to sort of chase them down with my mouth like Pac Man. The other thing I missed was a normal bathroom. The bathrooms up there could have really benefited from a little artificial gravity.

Q. How was the view?
A. What most people don't realize is that we were really only a small distance above the face of the earth—150 miles, roughly. If you have a globe the size of a basketball, that's about an eighth of an inch above it. So we didn't get the big picture, like the people who went to the moon, where they saw all of Spaceship Earth out there. We saw a horizon that was just very gently curved, and we could pick out things as small as Boston Harbor and the Golden Gate Bridge. It was very beautiful, though, seeing the whole rainbow of colors on the earth.

Actually, the biggest problem I've had since the mission is finding the words for my feelings and experiences, which has led me to think that NASA's plan for sending writers into space is a good idea. We were really trained technically and scientifically; we haven't been trained to express a lot of these things. I think it would be terrific to send a few writers up there and see what they come up with.

Q. How did you cope with zero gravity?
A. Not too well at first. There were two old pros on board, and when we first got into weightlessness, they were able to control their body motions pretty well; but the rest of us were very wild—we were bouncing off the walls. If you tried to do things too rapidly, you went out of control. And every time you tried to push against something, you'd move in the opposite direction: Newton's Law.

Q. Do you think the space program is at the point where ordinary citizens can go up?
A. You're looking at one who did.

Under the Domes

SIDHU BANERJEE, '87, FROM THE TECH

The cries of "two, four, six, eight—can't afford to graduate" were barely audible from a small group of protesters late last winter when President Paul E. Gray, '54, announced a 7.3-percent tuition increase (to $10,300) for 1984-85. The "general Institute strike" promised by one student group if the new tuition figure exceeded $10,000 failed to materialize.

Tuition Set at $10,300 for 1984-85 Living Up 5.7 Percent; Financial Aid Will Rise

Tuition, room, and board at M.I.T. will be 6.8 percent higher next year—a total of $14,400.

Tuition alone, which was $9,600 this year, will be $10,300 next year, a jump of 7.3 percent.

The average of room and board charges—costs differ slightly in different houses and with different meal plans—will rise from $3,880 this year to $4,100 next year—up 5.7 percent.

In announcing the increases, President Paul E. Gray, '54, pledged that funds available for student aid will be increased comparably, so that the Institute will continue its twin policies of admitting students without regard to financial need and of meeting the demonstrated need of all undergraduate students. Some 52 percent of M.I.T. undergraduates now receive some form of financial aid—loans, academic jobs, and grants—and that percentage will increase slightly next year. A total of $13.75 million in grants from M.I.T. and outside agencies was provided to undergraduates in 1983-84.

The tuition increase was not unexpected in view of forecasted budget deficits in 1983-84 and 1984-85, but student protesters were unable to marshal much concern. □

Bad dropouts

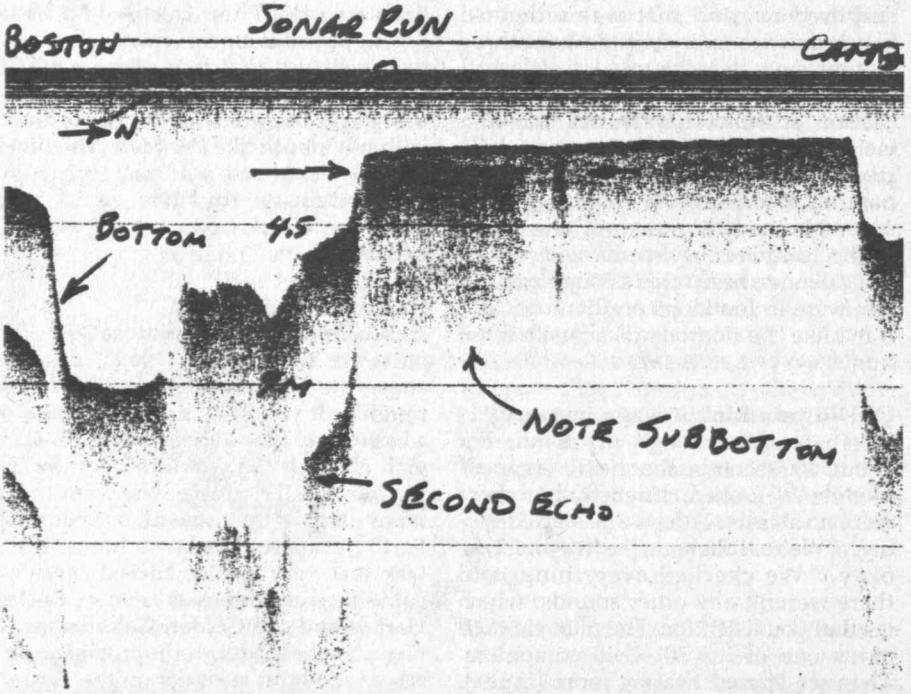
A New Attack on the Mysteries of the Charles

To Robert J. Holden, former associate dean at M.I.T., the Charles River is a "small provincial stream which continues to nourish bountifully our minds, our affections, our well-being, and the quality of our lives" (sermon for the Unitarian Society of Wellesley Hills, June 1983).

But to Professor Harold E. Edgerton, '27, it's a laboratory—a place to introduce students to the frustrations of engineering experiment and the joys of scientific learning. And for every question answered by a new sonar record of the bottom of the Charles River Basin, "Doc" Edgerton finds two new ones to ask.

Spring finds him out again (**below**) with a new class of initiates into the small fraternity of those with hands-on experience with sonars, "pingers," and the Edgerton mystique. This time it's a

Continued on the next page



north-south crossing from the Sloan Building to Boston.

A successful trip—the sonar (**below, opposite**) clearly shows the so-called "Sullivan's flats" barely covered by water just off Memorial Drive, deeps from which soil was lifted to form Memorial and Storrow Drives, and the original river channel before it was covered by water to become the basin.

But there's also the inevitable intriguing new question. Under part of Sullivan's flats there's a secondary echo. It's thought to result from dead marsh grass buried under sediment. But why no echo from under more than half of the area?

Ask "Doc's" next class. □

Introduction to Success

Entrepreneurship and how to do it, with first-person accounts by successful investors and managers, will be the focus of symposia during Technology Day on Friday, June 8. The all-day program is planned for all alumni, and it will be included in the programs of most of the class reunions scheduled for the days preceding and following Technology Day.

Other traditional features: M.I.T. Night at the Pops, with John Williams conducting the Boston Pops Orchestra on Thursday, June 7; and the annual luncheon and end-of-the-day reception on Friday, June 8, for all alumni. For information: Joseph J. Martori, Room 10-110, M.I.T., Cambridge, Mass. 02139. □

Presidential Investigators

Five members of the M.I.T. faculty were honored by the White House and its Office of Science and Technology Policy late last winter as Presidential Young Investigators:

□ **Leonard P. Guarente,** '74, assistant professor of biology whose work is in the field of molecular genetics.

□ **John Hollerbach,** Ph.D.'78, assistant professor of psychology specializing in control systems and robotics.

□ **Gretchen Kalonji,** '80, Norton Assistant Professor of Materials Engineering.

□ **Frank T. Leighton,** Ph.D.'78, Assistant Professor of Applied Mathematics, a specialist in theoretical computer science.

□ **L. Rafael Reif,** associate professor of electrical engineering, whose work is in integrated electronics.

Presidential investigators are honored for their major contributions through teaching and research in the first years of their academic careers. Each receives $25,000 a year in direct grants from the National Science Foundation for five years, and the government will match additional private grants to yield a total of up to $100,000 a year. The idea is to help universities attract and retain outstanding young Ph.D.s and junior faculty who might otherwise be lured by high salaries into nonteaching work. □

MacArthur Picks Two

Two more members of the M.I.T. faculty—the total is now seven—were tapped in the latest round of "MacArthur Magic" late last winter: no-strings-attached cash grants from the John D. and Catherine T. MacArthur Foundation. The new recipients:

□ Heather N. Lecthman, professor of archeology and ancient technology in the Department of Materials Science and Engineering.

□ Michael J. Piore, professor of economics in the School of Humanities and Social Science.

Lechtman will receive $236,000 between now and 1988, Piore $216,000.

H. Lechtman

M. Piore

The MacArthur Foundation's idea is to give "exceptionally talented" people grants that will free them from economic pressures so they can devote themselves fully to scholarship and research.

Professor Lechtman is director of the Center for Materials Research in Archaeology and Ethnology, and she will use the funds to continue field research

Olympic Hospitality by M.I.T. Club of Southern California

Visitors to the 1984 Summer Olympics will find a warm welcome from the M.I.T. Club of Southern California—an unusual offer of family housing and an all-M.I.T. Mixer at the exclusive Jonathan Club in downtown Los Angeles.

Alumni, faculty, and students who want short-term housing in the Los Angeles area during the Olympics are invited to write the club's housing coordinator, Mardi Margowsky, S.M.'78, using the form below or providing equivalent information. Members of the club have volunteered space in their homes, but the club will make no guarantee that housing will be available for all who request it.

All alumni, faculty, students, families, and friends in Los Angeles for the Olympics are invited to the club's preopening ceremonies mixer on Friday evening, July 27, from 5 to 9 at the Jonathan Club, 545 South Figueroa. There will be generous hors d'oeuvres, a cash bar, and a modest cover charge. □

For Summer Olympics housing, send this information now to the M.I.T. Club of Southern California

Name _____ Class and Course _____

Address _____

Telephone: Home _____ Business _____

Number in party _____ Number of rooms _____ Children? _____

Dates: Arrival _____ Departure _____

Comments and special requirements (e.g., smoking, transportation, etc.:)

_____

Complete and mail this form promptly to
Mardi Margowsky, 14021 Marquesas Way, #216C
Marina del Rey, California, 90292

in South America, to obtain technical help in her laboratory, and to create post-doctoral fellowships in her field.

Professor Piore, who holds the Matsui Chair in the Problems of Contemporary Technology, divides his time between the Department of Economics and the Program in Science, Technology, and Society. His specialty is in labor relations, where he is author of a "dual labor market" hypothesis to explain and predict how workers and jobs are matched. □

Register Ready in June

Data-gathering for the 1984 *Alumni Register* is now completed, says Barbara A. Durland, director of alumni information management—if you haven't brought your records up to date, it's now too late.

But it's not too late to order copies of the book due off the press by early June. There will be alphabetical and geographic lists and tabulations of all graduates by Course; also a complete list of deceased alumni since the founding of the Institute. Prices: $21.95 for softcover, $29.95 for hardcover deluxe edition; orders to Ms. Durland at Room 12-090, M.I.T., Cambridge, 02139. □

Chisholm at Commencement

Shirley Chisholm, the first black woman ever elected to Congress, will be the Commencement speaker on Monday, June 4.

Ms. Chisholm, who left Congress last year after seven terms in the House of Representatives, is now Purrington Professor at Mount Holyoke College, South Hadley, Mass., teaching courses in women's and racial issues. Before going to Washington she was for four years a member of the New York State Assem-

LILLIAN KEMP

How do technological developments affect world diplomacy? was the question for Kurt Waldheim (left), former secretary general of the United Nations, at an M.I.T. luncheon sponsored by the Macroengineering Research Group. With Waldheim in the picture is Frank P. Davidson, M.I.T.'s chief macroengineering advocate.

bly, and in both assignments she earned a reputation as outspoken advocate of women, minorities, and the poor. □

No Retreat on Title IX

When the U.S. Supreme Court limited the reach of the federal law prohibiting sex discrimination in colleges receiving federal funds, M.I.T. officials observed from the sidelines. There will be no effect at the Institute, said Patricia Bell-Scott, the assistant equal-employment-opportunity officer.

The original position of the Justice Department was to withhold all federal funds flowing to a university if sex discrimination was found in *any* of its programs. But under the new ruling, federal funds are to be withheld only from those programs in which sex discrimination occurs. Athletic programs for women are generally thought to be at greatest risk under the new interpretation. But M.I.T. remains "fully committed" to athletics for both men and women, said Bell-Scott. □

Research Up 10 Percent

Total on-campus sponsored research at M.I.T. will be just under $220 million in 1983-84, up about 10 percent over the previous year, according to estimates by Robert M. Dankese, budget director. At $55 million (compared with $48.3 million in 1982-83), the Department of Energy will be the largest single sponsor, with the Department of Defense a distant second at $36 million. □

Honoring Alumni Industrial Leaders While Celebrating M.I.T.'s Industrial Ties

While they were M.I.T. roommates, Robert W. Mann, '50, was looking forward to a career at Bell Labs and Kenneth H. Olsen, '50, wanted an academic job, preferably at M.I.T. But Mann is now Whitaker Professor at M.I.T., Olsen president of Digital Equipment Co.—just an example, says Mann, of how academic and industrial interests are interwoven through the M.I.T. community.

Professor Mann's comments on M.I.T.'s "fertile, productive relationship with industry" came during the luncheon to honor 42 alumni with the Institute's Corporate Leadership Awards on March 2. With many previous awardeees in the audience, David S. Saxon, '41, chairman of the Corporation, was able to note the top leadership of "a measurable fraction of the U.S. GNP" assembled to receive awards or to applaud recipients. Holders of the awards are alumni with responsibilities in industry as heads of major companies.

The new awardees:

□ **J. Perry Barger,** M.E.'56, president and chief executive officer, Dynatech Corp.

□ **Tom H. Barrett,** S.M.'69 Sl., president and chief operating officer, Goodyear Tire and Rubber Co.

□ **Samuel W. Bodman III,** Sc.D.'65 Chem.E., president and chief operating officer, FMR Corp.

□ **Richard T. DiBona,** '55, chairman, president, and chief executive officer, M/A-COM, Inc.

□ **Allan M. Doyle, Jr.,** '52, vice-chairman and chief financial officer, Kollmorgen Corp.

□ **John F. Fort III,** S.M.'66 Mgmt., chairman, president, and chief executive officer, Tyco Laboratories, Inc.

□ **Andre Gillet,** '68, president, chief operating officer, and director, International Multifoods

□ **Bernard M. Gordon,** '49, chairman, president, and chief executive officer, Analogic Corp.

□ **Carlos N. Graf,** '51, president and chief operating officer, W.R. Grace & Co.

□ **Dwight H. Hibbard,** '49, president and chief executive officer, Cincinnati Bell, Inc.

□ **James B. Hoaglund,** '45, chairman and chief executive officer, McQuay, Inc.

□ **James J. Howard,** S.M.'70 Sl., president and chief operating officer, Ameritech

□ **John O. Howell,** '67, president and chief executive officer, McDowell Enterprises, Inc.

□ **Terry J. Kohler,** '62, chairman and chief executive officer, The Vollrath Co.

□ **John Lawrence,** '32, chairman of the board, Recognition Equipment, Inc.

□ **Norman B. Leventhal,** '38, chairman, The Beacon Cos.

□ **David A. Lewis,** S.M.'67 Sl., president and chief operating officer, Continental Bank of Canada

□ **Richard G. Marcus,** '69, president, American Biltrite, Inc.

□ **Robert G. Marcus,** '31, chairman of the board, American Biltrite, Inc.

□ **Steven C. Mason,** '57, president and chief operating officer, The Mead Corp.

□ **William T. McCormick, Jr.,** Ph.D.'69 Nucl.E., president and chief operating officer, American Natural Resources Co.

□ **Harold A. McInnes,** '49, President, AMP Inc.

□ **Kendrick B. Melrose,** S.M.'65 Mgmt., vice-chairman, Stauffer Chemical Co.

□ **Harold S. Mickley,** Sc.D.'46 Chem.E., vice-chairman, Stauffer Chemical Co.

□ **Richard D. Morel,** '49, president and chief executive officer, Algonquin Energy, Inc.

□ **Robert Oppenlander,** '44, vice-chairman of the board and chief financial officer, Delta Air Lines, Inc.

□ **Charles E. Peck,** '46, chairman and chief executive officer, The Ryland Group, Inc.

□ **Generoso P. Pope,** '46, chairman, *National Enquirer*

□ **John S. Reed,** '61, vice-chairman, Citicorp

□ **Erick T. Ringkjob,** '60, president and chief executive officer, Prolink Corp.

□ **Otha C. Roddey,** S.M.'51 Chem.E., president, The Parsons Corp.

□ **John A. Rollwagen,** '62, chairman and chief executive officer, Cray Research, Inc.

□ **Mark K. Rosenfeld,** S.M.'70 Mgmt., president, Jacobson Stores, Inc.

□ **Brice R. Smith, Jr.,** S.M.'52 C.E., president, Sverdrup Corp.

□ **Steven J. Smith,** '62, president, Ryan Homes, Inc.

□ **Carl G. Sontheimer,** '37, president, Cuisinarts, Inc.

□ **J. Spencer Standish,** '45, chairman, Albany International Corp.

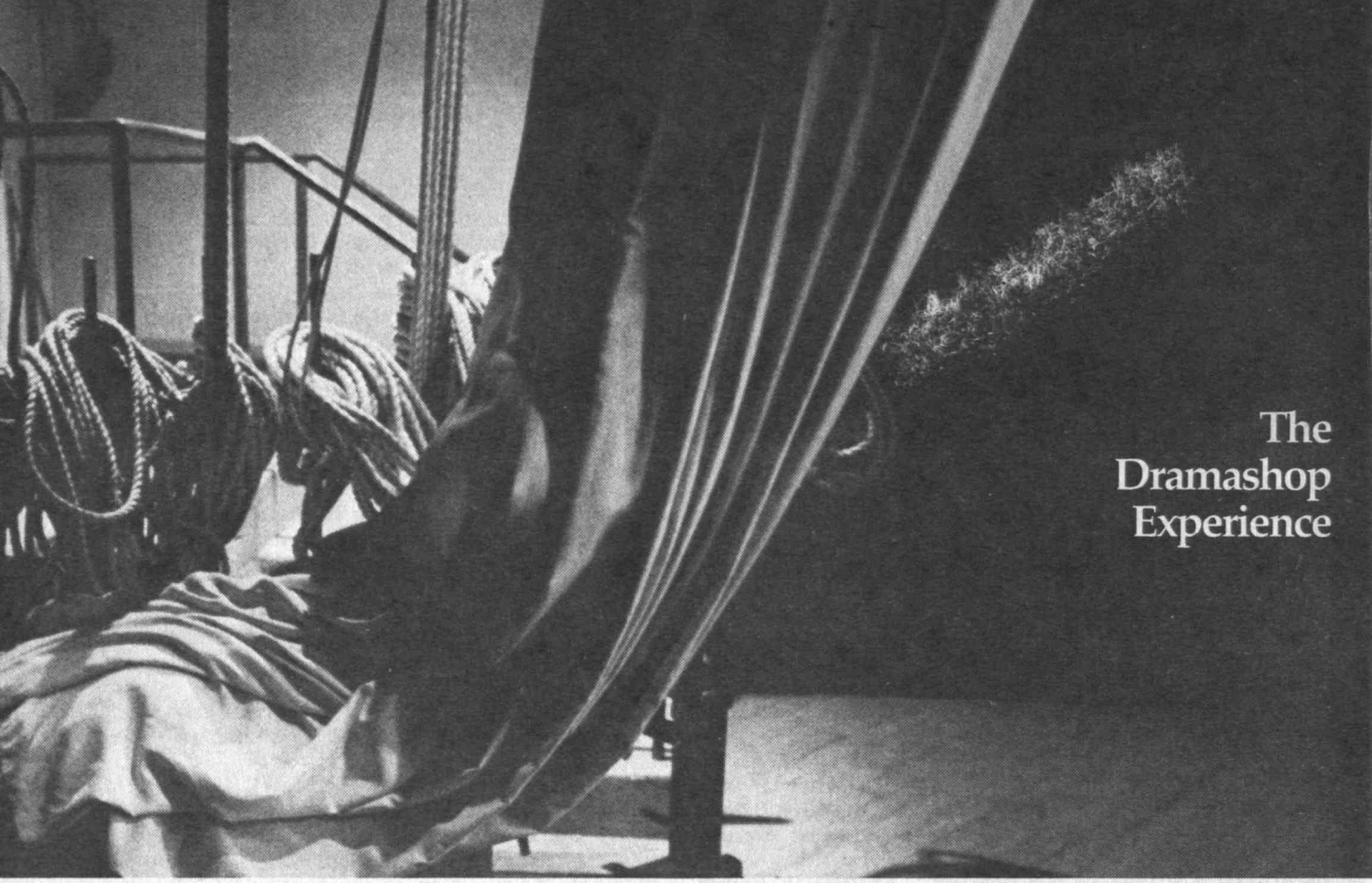
□ **W. John Swartz,** S.M.'67 Sl., president, Santa Fe Industries, Inc.

□ **Edward T. Thompson,** '49, editor-in-chief, *Readers Digest*

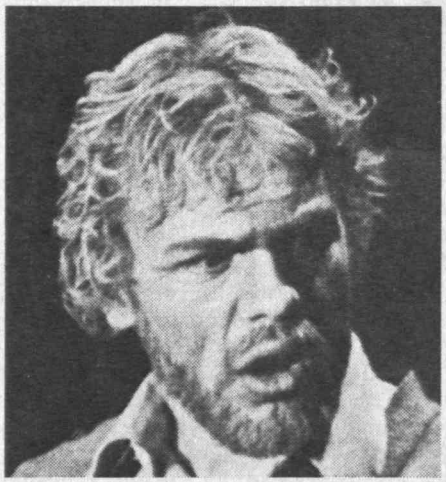
□ **Edward B. Walker III,** '44, president and chief operating officer, Gulf Oil Corp.

□ **Donald H. White,** S.M.'70 Sl., president, Hughes Aircraft Co.

□ **Kay R. Whitmore,** S.M.'75 Mgmt., president, Eastman Kodak Co.



The Dramashop Experience



Above: **The Clandestine Marriage** *by David Garrick and George Colman, directed by Robert Scanlan and Wayne Heller, '86. Actors left to right: Anjali Sastry, '86, Bill Bryant, '83, and Joel Gluck, '86. Right (upper): Ernie Fasse, '85 in* ***Percy Granger's*** **Vivien,** *directed by Michael Combs, '84. Left: David Collins, '86, Susan Botti, Wellesley, and Ian Dowell, '86 in Bertolt Brecht's* **The Caucasian Chalk Circle.** **(Photos: Top, Frank Revi, '86; Bottom, Tom Bloom)**

Be bold, show a range of voice," coaches Robert Scanlan, '70 (left in top photos with student director Kevin O'Connell, '85), director of the M.I.T. Drama Program. "We're going for acting qualities; it's not so important to have the words just right," he tells those auditioning for the late winter plays.

All roles in the three sets of one-act plays and two full-length plays produced by Dramashop each year are open to students with or without experience. The result is that Dramashop has about 120 members, including 30 drama concentrators, supported by a small professional staff. The goal is to provide a laboratory experience where students participate in designing, directing, and in some cases actually writing the plays—as well as acting in them.

There are two main thrusts of the program, explains Scanlan:

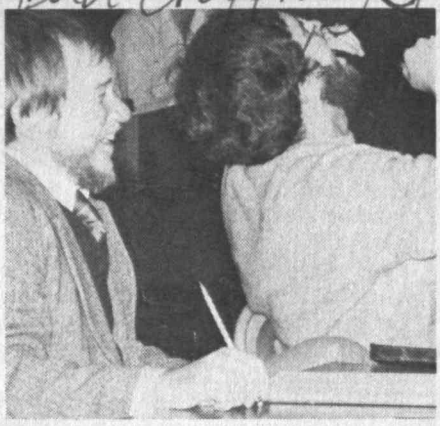
☐ To give students technical performance skills. They learn to think of themselves as instruments, actors who create a work of art, and they acquire the technical means to do that.

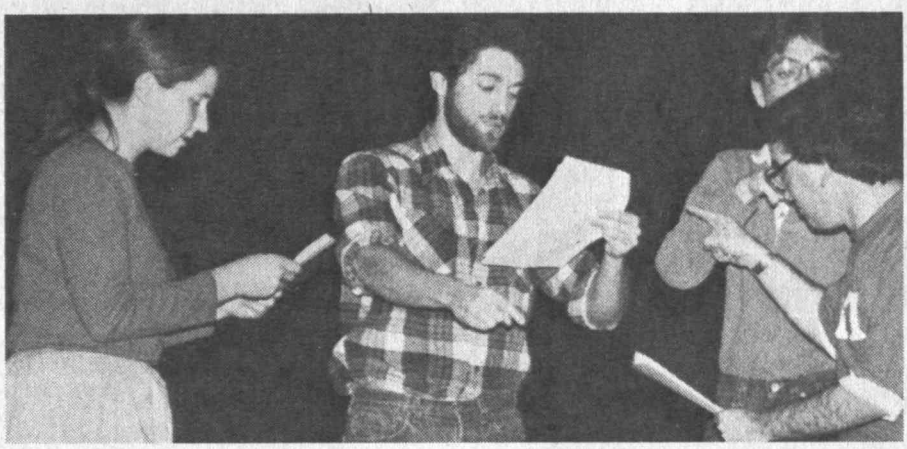
☐ To lead students to the comprehension of drama as a formal structure. "This part of the program has a close analogy with what they're doing in their scientific work. They're used to making conceptual and formal models of reality, and I draw on that as often as possible," says Scanlan. "A play script contains encoded material and is structured the way it is in order to bring out action. When the students get inside a play by performing it themselves, they come to know what a dramatic work of art is and to understand what's going on in the playwright's mind.

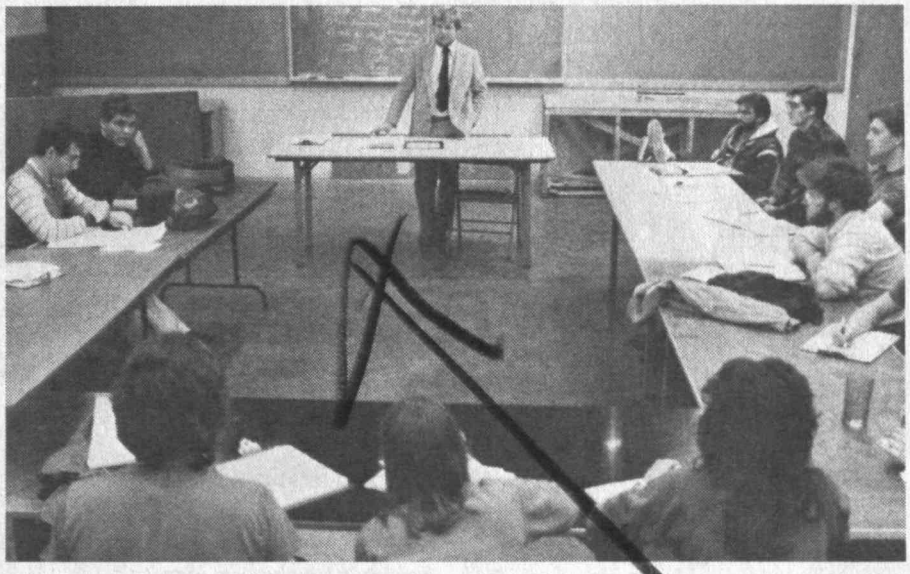
Costumes and sets add to the play's interpretation by extending the illusion the actors are creating. Soon after casting, a production meeting is held (photo, lower right) to coordinate the technical details of the sets with the costumes. Should the sets be realistic or designed to create an abstract impression? How will the costumes play against the background?

What do the participants gain from the Dramashop experience? "It sharpens their observational skills," says Scanlan. "They have to latch on with their minds and imaginations to what they're visualizing and then enact that visualization. They learn simple things like different ways of standing and walking, balancing, gesturing—skills of deportment. There's an incidental therapeutic side as well. Being able to get out of themselves and totally concentrate on being somebody else gives them another perspective, an awareness—self-knowledge," Scanlan says.—*S.K.*

(continued)

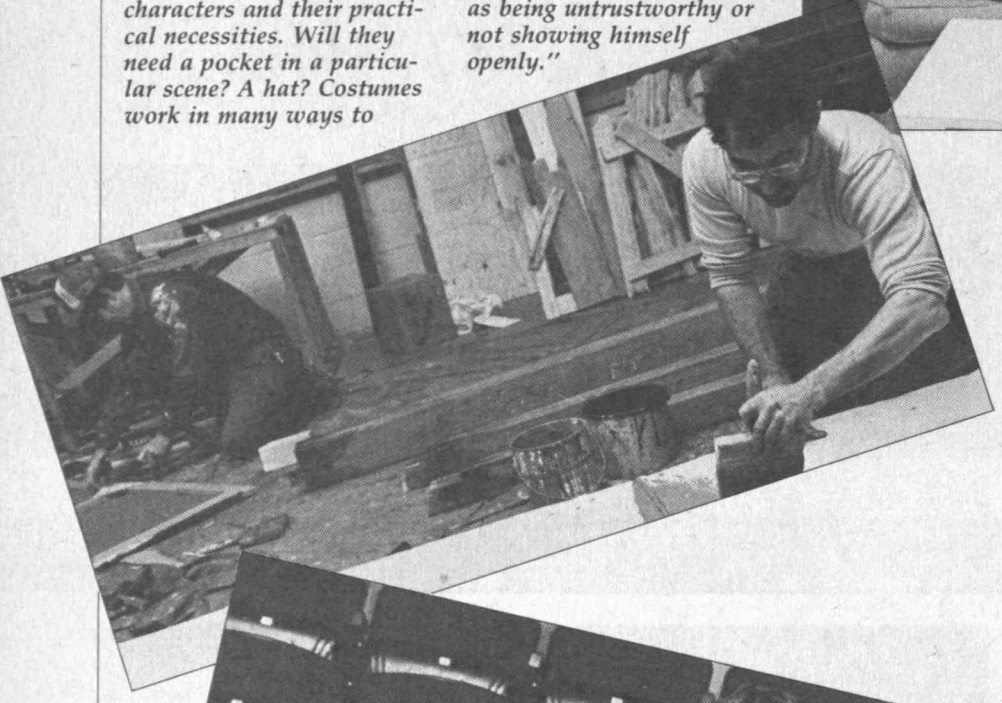




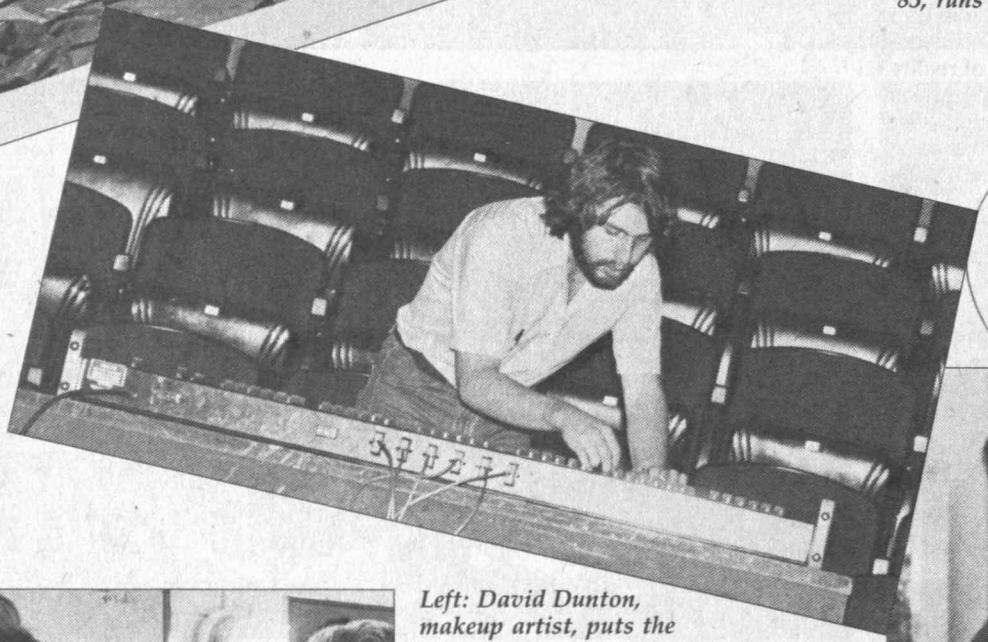


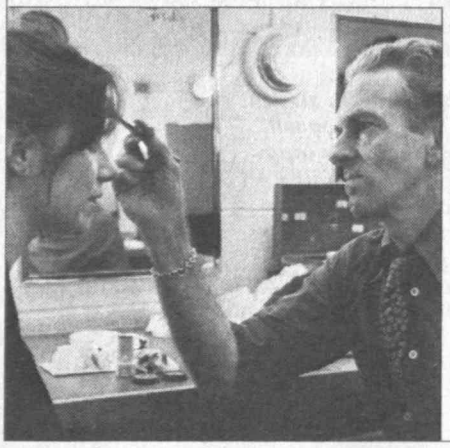
It's less than three weeks from casting to performance for the M.I.T. Dramashop's one-act plays. Auditions are open to the M.I.T. community, and many of the participants have had no previous theatre training. Robert Scanlan, '70, director of the M.I.T. Drama Program (left in top photos) with student director Kevin O'Connell, '85, direct auditions (middle photo) for last fall's set of one-act plays. Shortly after casting, a production meeting is held (lower photo) to coordinate details with cast and crew. **(Photos: Frank Revi, '86)**

"Costuming is planned within the overall context of stage setting and with the director," says Margaret Hall (right), Dramashop costumer. First she reads the play so as to have a clear picture of the characters and their practical necessities. Will they need a pocket in a particular scene? A hat? Costumes work in many ways to convey the atmosphere and illusion being created. They reflect time, place, the weather, economic status, details of character. "For instance," she says, "you might use a shifting color fabric to depict a character as being untrustworthy or not showing himself openly."



Left: Edward Darna, technical director (left), and Bill Fregosi, set designer/artist, prepare a set from a supply of basic flats, doors, windows. "It's amazing the way the actors absorb their surroundings and feed it back in their performance. Sometimes their acting improves by leaps and bounds with each tech rehearsal," says Darna. Below left: Lighting—Keith Brezinsky, '85, runs the dimmer board.

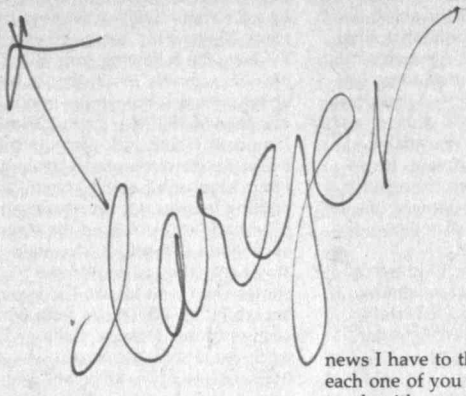




Left: David Dunton, makeup artist, puts the finishing touches on Jean Alpers, '86. Right: Kevin Cunningham, '82, shakes the nervousness from his hands while he holds his concentration in the "Green Room," where actors prepare just before going on stage.

PHOTOS: FRANK REVI, '86

Classes



08

A letter from Alice Pentlarge Loeb informs us that her husband, **Leo Loeb,** passed away on January 30. He was 99. Mrs. Loeb's documents include Anne L. Ratner's handwritten biographical notes as dictated by her father on June 16, 1981, where he remembers his boyhood in Rock Hill, Mo. "I was 'Poppa's boy' and tried to be with him as much as possible. It became my job to clean out the horse's stall each morning . . . I used to sell milk, delivered it in a granite bucket . . . collected five cents per bucket."

Leo Loeb's career took him many places far from Rock Hill. Following graduation from M.I.T., he was employed as a junior engineer with the United States Bureau of Mines and later as an instructor in mechanical engineering at Rensselaer Polytechnic Institute in New York. In 1912, he became senior mechanical engineer at the Naval Engineering Experiment Station (EES) at Annapolis, Md.

Centerline, the station's newsletter, features Leo in its February 12, 1982 issue. It quotes him as having spent the happiest time of his life at EES (now the David Taylor Research and Development Center in Bethesda). Leo later became professor of marine engineering in the Post Graduate School of the United States Naval Academy.

Leo was essentially a teacher not only at Rensselaer and Annapolis but wherever he went as a consultant; he supervised and trained younger men, says Mrs. Loeb. To him, engineering was not only a profession—it was a passion. Above all, he prized the integrity of his work. He was eventually associated with public utility valuations and negotiated numerous contracts for the purchase and sale of manufactured gas, natural gas, and electricity. He also appeared as expert witness in cases before regulatory bodies in Florida, Georgia, Kansas, Maryland, Missouri, Washington, West Virginia, Wisconsin, and Wyoming, as well as before federal agencies including the Securities and Exchange Commission and the Federal Power Commission.

No matter what changes his later life brought, his affection and devotion to M.I.T. remained undiminished. To have been chosen to work on the Development Committee was one of the greatest sources of satisfaction to him in his later years. He was proud of being a sustaining fellow and founding life member of M.I.T., and he loved receiving the Bronze Beaver Award in in 1972.

In addition to his wife, he is survived by two sons, Leo and Richard, a daughter Anne, five grandchildren, and four great-grandchildren. Our sympathy is extended to his family.—*Ed.* (**Harold Osborne,** Secretary, Penacock Rd., Contoocook, NH 03229)

15

Hi '15ers . . . The sun is shining brightly this afternoon, and I'm all perked up to give all the news I have to the good old gang! Intend to drop each one of you a note in the near future, to be in touch with you personally and to remind you of the M.I.T. 1984 Alumni Fund (which will end June 30) *or* to thank you for joining!

Have been in touch with **Loring Hall.** Hopefully we will have some more of his college day notes to put in our next issue, so look forward to those as a coming attraction!

Carl W. "Pop" Wood is a member of the Peterborough (N.H.) Civil Defense, Masonic Lodge No.26, American Legion, Chaney Armstrong No. 10, Rotary, and the Union Congregational Church. Nice going, Pop. Keep up the good work and all the activities!

The Institute has forwarded me notices of two of our Class Supreme passing on to better things. **Ellis S. Tisdale** died October 3, which saddens us. He attended Needham schools, graduated from M.I.T., and later served as a public health officer. From 1955 to 1962 he served as the director of the interstate commission of the Potomac River Basin in Washington. He is survived by his wife Florence G. (Belyea) Tisdale; a daughter, Ruth T. Jackson of Santa Cruz, Calif.; four grandchildren; and a sister, Ruth Stevenson of Jaffrey, N.H.; and three great-grandchildren. . . . **James S. Stewart** died, but unfortunately we have no further information on him.

Have had no further word from any of the Class Supreme. We need news for our column. Please get in touch, simply giving me a few lines of how you are and what you are presently doing! I'll be waiting!—**Joyce E. Brado,** Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, N.Y. 14094

16

Memories . . . this time of year has many happy memories for the members of the Class of 1916 of the great reunions that we had on the Cape at the Oyster Harbors Club and the Chatham Bars Inn. In 1951, the decision was made to begin having annual reunions. Shortly thereafter wives, girlfriends, and family were invited to share in the joy of reunions.

These added substantially to the interest and enthusiasm of our reunions. This also provided a broader base from which to gain ideas and workers for planning and executing our magnificent 50th reunion in 1966. With a blast from a cannon to start and then to the accompaniment of the blare of trumpets provided by members of the Boston Symphony Orchestra, our classmates made their triumphant entry into the cage where all classes gathered for the Alumni Day luncheon.

Our class gift chairman **Joe Barker,** costumed as Jason and carrying "The Golden Fleece," was transported to the speakers' platform in a replica of the *Boucentoro,* a Phoenecian-styled ship propelled by six classmates manning the oars. The 50-year class gift was in excess of $3 million, which established a record.

George I. Crowell (right), '16, of T. F. Crowell and Sons building contractors, receives a plaque commemorating his 50 years of service on the board of directors of Plymouth Home National Bank, Brockton, Mass. (Photo: Stanley Bauman)

That 50th reunion was the beginning of the Red Jacket tradition which has been emulated by most of the 50-year classes since 1966. The idea was approved at one of the early committee meetings and **Jim Evans** made the necessary arrangements. His was the first jacket and is now on display at the M.I.T. Museum. We also established a new high with over 100 classmates (185 including wives and guests) returning. That had to be the most exciting and pleasing reunion, but all of them before and after have happy memories of the wonderful people with whom we had the pleasure to associate over so many years.

Had a nice note from **John Fairfield:** "Thanks for the picture of **Dina Coleman** in the recent class notes. It is pleasant seeing him honored and holding his own as entertainer and raconteur. Dina is a most interesting member of our class—versatile, affable, and now enjoying life, friends and honors." . . . We received two death notices: **Victor Dunbar** in July 1983 and **Edgar Hanford** in November 1983. No further details at this time. . . . Keep eating, drinking, walking, breathing—everything in moderation and, of course, keep writing to us.—**Bob O'Brien,** Acting Secretary, H.E. Fletcher Co., Groton Rd., West Chelmsford, MA 01863

17

Harrison P. ("Bill") Eddy writes from Captiva Island, Fla., "I walk a mile on the beach every day and am healthy as a rat."

More than three years ago there occured a death which was only recently reported to us. **Adolp ("Dad") Wenzell** died on December 11, 1980. He was then living at the Onteora Club in Tannersville, N.Y.—**Walter J. Beadle,** Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

18

Sometimes the mails are slow but eventually they get to me. I am happy to report in this issue the following items of interest to all of us. Judith and

Henry "Hank" Stephens sent a gorgeous card from Honolulu. He writes, "I am director and occasionally president of the board at Seaside Towers where I installed a roof which does not leak, self-closing garage doors, and heat pump to heat hot water. I have broadcast a health program over a local radio station for the past 12 years and am active in an exercise class daily on the beach at Ft. DeRussy Waikiki (we had 109 in class today).

I report with sadness the passing of **Harold Weber** on February 11. After graduating from M.I.T., he served in the U.S. Army Chemical Warfare Service. From 1919-22, when he returned to M.I.T. he was a consulting engineer for a Boston firm. In 1922 he was appointed assistant professor of chemical engineering and assistant director of the Boston Station of the Chemical Engineering Practice School, becoming its director from 1923-28. He became associate professor in 1928 and full professor in 1941.

From 1941-45 Dr. Weber was technical advisor to the commanding officer of the Chemical Warfare Service Department Laboratory at M.I.T. He was the recipient of many honors as a civilian and an army officer during both world wars, one of which was the Presidential Certificate of Merit. He later became chief scientific advisor to the Chief of Research and Development.

Following his retirement from M.I.T in 1960, Weber and his wife Marian, who survives him, made their home in Sun City. It was my good fortune to have known him through the years. He exemplified those qualities that distinguish M.I.T. excellence. . . . Keep the news items coming—I will appreciate all you send.—**Max Seltzer,** Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, MA 02146

19 65th Reunion

We regret to report the death of **Amos N. Prescott** on December 1, 1983, at Chagrin Falls, Ohio. Before retirement he was vice-president of J.I. Prescott Co. of Passaic, Me., a family business founded by his father, producing household and commercial chemical products. He was very active in community affairs. He is survived by his wife, a son of the same name, a daughter Helena, a brother Robert, six grandchildren, and six great-grandchildren. He was indeed a credit to our class. No news has reached us for these notes.

Our minds are full of thoughts about our 65th reunion. The next notes will post you on the event. Do have a lovely summer.—**W.O. Langille,** Secretary, Box 144, Gladstone, NJ 07934

20

Welcome news from my old friend, Ken Roman, who writes that he is semi-retired from his long service as manufacturers representative in the textile field but is acting as a consultant for another company in the same area. Ken has been married to Bernice for 54 years. He has a son, a daughter and three grandchildren. Ken resides at 10 Emerson Place, Boston. . . . **George Wilson** writes that he is considering how to dispose of his large mineral collection. He confesses that his candlepin bowling average has fallen below 80. George continues very active in Kiwanis. . . . **Solomon Passell** of Southfield, Miss. died in 1982. . . . **Jacob Novack** of Brookline, Mass. died on July 28, 1983. . . . Major General **Roger B. Colton** of Alexandria, Va. died in 1978. I do not have further information about these classmates.

B. Alden Thresher, whom his classmates knew as "Bat" died on January 23 at his home in Winter Park, Fla., where he had retired in 1961. Bat was considered the dean of admissions officers in the United States. He was director of admissions at M.I.T. for 25 years, was chairman of the College Entrance Examination Board at one time and was on the board of Educational Testing Services. His book, *College Admissions and the Public Interest* was a best seller among college administrators. A professor at M.I.T. since 1929, he decided to accept President Carl Compton's request that he take charge of admissions. At the time of his retirement, President Killian stated that he was recognized as "one of the ablest members at M.I.T., an influential administrative officer, and greatly beloved by his associates." Dr. Stratton also mentioned his outstanding contributions to achieving more effective communication between secondary schools and colleges and universities. Dr. Stratton stated, "His analytical approach, his willingness to experiment, his integrity and humanity, and his deep concern for the welfare of students justifiably brought him wide recognition in the problems of college admissions."

Bat leaves two daughters, a son, 13 grandchildren and no less than nine great-grandchildren. He reflected great credit to his class.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, MA 01890

21

It's a sunny February day in Sarasota, Fla. as these notes are being written. Betty and I leave to go home the end of this month. As usual our social life down in Florida has been busier than the rest of the year. One day Graciela and **Helier Rodriguez** drove down from Tampa to a luncheon hosted by Claudia and **Josh Crosby**. On other days the **Herb Kaufmanns** were hosts to the **Sumner Haywards** and the Haywards hosted a luncheon for the Crosbys and the Kaufmanns. Kay (Mrs. **Larcom) Randall** is still living in her beach-front condominium, and the Haywards dropped in one day for wine and cheese snacks. And lastly, your secretary has walked the beach several times with Alice (Mrs. **Bob) Felsenthal.** On February 23 the M.I.T. Club of Southwestern Florida has a luncheon meeting in Ft. Myers and the Crosbys and Haywards are driving down. We are hoping that several M.I.T. '21 men living in Ft. Myers and Naples will be there.

Phone calls to other '21ers in Florida reached **Dick Spitz** on Longboat Key, Sarasota, **Dick Windisch** in Naples, and Celia (Mrs. **Frank) Huggins** in Ft. Myers. All reported being in fine shape for the shape they were in—in other words having some health problems but getting along reasonably well. Dick Spitz is no longer doing volunteer work at the hospital and has stopped going to Martha's Vineyard for the summers.

Two Alumni Fund envelopes brought in a bit of news. **Horace Tuttle** writes, "Sorry we can't go much this year. Pearl had two heart attacks early in 1983. I would like to have gone to the Masonic Temple in North Cambridge for installations of new officers. I joined the group when the Richard MacLauren Lodge was under dispensation in 1921 and am still a Mason." . . . **M.H. Naigles** writes, "My major occupations since graduation have been: SEC Research Division, 1934-39; Bureau of Labor Statistics, 1939-43; War Shipping Administration, 1943-46; president of Dolphin Swimming Pool Co. in New York, 1949 to present time. My experiences have been rich, and rewarding."

Four deaths have been reported this month: **Gunnar Amundsen,** Oslo, Norway on December 12, 1972; **Ethan A. Beer,** St. Louis, Mo. on January 26, 1978; **Gustav Carlsson,** Stocksund, Sweden on October 23, 1983; **Julius Gordon,** Wilmington, Del. on October 26, 1983. I have no information at hand on the careers of these men.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby,** Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33679; **Samuel E. Lunden,** Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA

22

A note from **Theodore Shlikoff** who must be our oldest classmate. "Next May 29, 1984 I'll be 96 years old. I still enjoy a cigar or two every day. I'm living at the Marshall Manor Nursing Home at Guntersville, Ala. My guardian and good friend Gregory Moshkoff and his wife Mary look after me. They invite any of my friends to come by for a visit." Shlikoff was in Course II. *Technique* '23 gives his home as Povenetz, Russia.

I have the following from **Bill Elmer**. "I've been inexcusably remiss in not having told you about a remarkable genius in our already cataclysmic class of 1922. I refer to **Eastman Smith** of Mountain Home, Ark., who in his mid 80's has become a concert violinist rivaling the famed Franz Liszt in his ability to win the adulation of adoring females. Countesses used to throw their pearl necklaces down on the stage to Liszt but the spellbound damsels of Mountain Home don't stop there; they rush onto the platform and shower him with kisses. I kid you not! He has a superb Ficker 1786 violin with which he plays such virtuoso works as violin and piano concertos by Spohr and St. Saens and, yes, two ladies actually did go up on the stage and give him sweet kisses. And the audience as a whole gave him a wild standing ovation. This remarkable man, a Doctor of Science, no less, should be written up not only in the 1922 Class notes but also in *Time* magazine as well. What an ornament to M.I.T.'s most outstanding class. In 1921 while I was an M.I.T. junior, Eastman managed a small musical ensemble that gave performances locally in Boston and I was privileged to be its accompanist, occasionally interspersing the programs with my own virtuoso solos. Now more than 60 years later it is heartwarming indeed to think that this brilliant human being is still functioning at the peak of perfection." Easty, as he was known in school, came to Tech as a sophomore after a year at Harvard. He is now 87. In addition to his musical activities, he was advertising manager of *The Tech Engineering News* and a contributor to *VooDoo*.

Walter L. Hunt, retired for many years in Unadilla, N.Y., died September 6, 1983. No details available. **Edwin C. Brown**, retired in Hillsboro Beach, Fla., died November 5, 1981. No details. **Evert Allan Reinhardt** whose last address was in Newburyport, Mass., died sometime in 1983. Again, no details.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

23

Your treasurer's report for the period October 6, 1978 through May 31, 1983, delivered at the class meeting on June 9, 1983 has been audited by the M.I.T. Audit Division. They wrote: "We reviewed the bank statements, records of receipts, expenditures, and supporting documents. The aforementioned report, which included our ending cash balance of $7,374.09 as of May 31, 1983, appears reasonable." We thank Mr. Francis T. Conroy and the Audit Division for this work. Any classmate who wishes to have a copy of the report may have one for the asking.

An article in *Wasteage* reports a project for recovery of methane from a small landfill in Florence, Ala., developed by **Atherton Hastings** in cooperation with the city gas department manager. It now has been operating successfully for over six months and has attracted many visitors some from a number of other states and Europe. The gas recovered has been used to heat animal shelters adjacent to the landfill and is sufficient to heat 200 homes.

Joseph Martin died on March 29, 1981. He studied electrical engineering subjects with our class. He worked for the Brooklyn Union Gas Co. for over 30 years until his retirement in 1966.—**Richard Frazier**, Secretary - Treasurer, 7 Summit Ave., Winchester, MA 01890

24 60th Reunion

The Reverend Canon **Denton Massey** who had been ill for some time, died in his sleep January

25, 1984 at his home in Kitchener, Ontario, Canada. He was probably the only M.I.T. engineer in our alumni to attain such an exalted capacity. Dent earned his S.B. in general engineering and was probably best known among his classmates for losing the rear end of his brand new Packard in a four-sided tug-of-war after Tech Night. The freshman had hitched a truck to the opposite end of the seniors' (Dent's) rope.

At the Institute he was captain of the hockey team and conducted sizeable Sunday classes on religious problems for TCA. This later developed into the York Bible Class in Toronto, Canada. More than 20,000 attended one of the meetings in the Maple Leaf Gardens, and the class eventually became a broadcast in Canada. Dent was deeply concerned about his mission to find answers to religious questions, but he also had avocations. He was in the infantry in World War I and pilot in the Royal Air Force in World War II, and a member of the House of Commons for 15 years. He was works manager at Massey Harris Co., Toronto for eight years, founded his own advertising agency, and established foreign and national auto dealerships. Many of his York Bible Class addresses closed with, "There is no road to the heart of God that does not lead through the heart of Man."

In January, **Herb Stewart** detoured through Florida and Georgia for a week on his way home from an IEEE convention in Dallas, Tex. While spending three days enjoying the hospitality of Etiennette and **Lafayette Quirin** in Florida, he had the experience of picking strawberries at a strawberry farm. Both are coming to the 60th reunion. On his way back north, Herb checked by telephone the homes of **John Fitch** and **Curly Fletcher** as to reunion prospects. The Fitches expect to come, and a later contact indicated the Fletchers were good possibilities.

An alumni register questionnaire reveals that Dr. **William Earl Messer** died December 21, 1980 in Hampton, N.H. He earned his S.B. and Ph.D. in chemistry and circa 1949 was with the Naugatuck Chemical Co., Naugatuck, Conn. . . . A newsclipping records the death of **William H. Couch** in Quincy, Mass., December 30, 1983. He was awarded an S.B. in chemical engineering and apparently joined the Simplex Wire and Cable Co., Cambridge, Mass., retiring as chief chemist after more than 40 years. He was a member of the Quincy Board of Appeals and the American Chemical Society.

Al Roig writes from Puerto Rico that his sixth great-grandchild has arrived. Al has recuperated from knee surgery and plans to participate in the complete 60th program. . . . **Jack Walthall**'s wife, Eva, sends an excerpt from her Christmas letter: "Jack bought himself a 27-foot boat, made in Washington state, for his 83rd birthday! He's wanted one that he could put on a trailer and haul hither and yon. Now he's bought a trailer, and we will bring it home from the factory. We still have our 50-footer in front of the house."

Dave Evans brings us up-to-date: "Married Mrs. Dorothy Cogie January 1, 1984. Made honorary governor of New Canaan Historical Society after 15 years as librarian and chairman of the library commission, and still active. In 1983, our society won a national award as No. 1 in the U.S. as 'All-Around Society' presenting local history."

When these Notes arrive, you may be taking off for Cambridge for that once-in-a-lifetime event, a SIXTIETH reunion. At this date, we can only speculate what pleasure June will bring us, to be itemized in the October issue.—Co-secretaries: **Russ Ambach**, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

25

A letter from **John Campbell** includes a *New York Times* clipping about South Africa's activities during World War II, which reminded him that our first class president, **Glen Bateman,** served with valor in the South African Air Force. John mentions that a double bypass operation in 1978 saved his life. A note from **Gates Burrows** tells us that he was a marshal at the 25th Annual Bob Hope Classic at Palm Springs—the seventh time he has enjoyed this task. While there, he spent some time with **Al Golemon**; they both expect to take their ladies to the 60th Reunion in 1985.

Raymond M. Trevil, now residing in Quebec Province, provides some interesting information, about his life. He graduated from Ecole Polytechnique in Paris before coming to the United States to study advanced management, joining our class for a little over a year. He partially supported himself by teaching technical French. Before returning to France, Raymond married an American, Stella Houston, whom he had met in Paris; their 58th wedding anniversary is this June. Starting in 1938, he worked mostly for the French diplomatic services in the United States, Canada, North Africa, and France, with emphasis on international trade, management methods, engineering, marketing and financing. Although he retired in 1965, he still specializes in economics and finances. Several family members are affiliated with M.I.T.: Raymond's daughter and son-in-law have Ph.D.s from the Institute, a grandson is now a Junior, and a cousin is a graduate student. . . . My older son Dick, '54, was in Tokyo on business for Digital Equipment Corp., and I suggested he get in touch with **Kamy Kametani.** They got together for lunch and had an enjoyable meeting. Kamy is in good health and looking forward to attending the 60th Reunion.

Finley Laverty reports that, although he is fully retired, advisory committees on flood control planning and on other civic problems add diversity to his life. He and his wife spend much of their time at home in Juniper Hills—their 4,700-foot elevation overlooks Antelope Valley and Edmunds Air Force Base. They are frequently in Pasadena where their apartment is only half a block from the Rose Parade. He is looking forward to hearing plans for the 60th Reunion. . . . **Russell Grove** writes from Marietta, Ga., that he has just about retired from the legal business. He enjoys his connection with the M.I.T. Club of Atlanta. . . . **James McGuire** reports that he is now retired from the business he started in 1928, which still operates as James M. McGuire Co., Inc., in New York, N.Y.

Many of us knew and remember **Toni Lauria** and possibly knew his wife. His son, Larry, wrote to say that his mother died on December 1, 1983, of heart failure after a short hospital stay.—**F.Leroy (Doc) Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

The National Society of Professional Engineers granted awards for the ten outstanding engineering achievements of the last 50 years at a special ceremony in the Sheraton Palace in San Francisco. One of the awards was to **Charles S. Draper,** who in 1948 succeeded in combining gyroscopes, small computers and accelerometers to produce the first true inertial navigational guidance system, with which his laboratory later designed and built the system for the Apollo projects command lunar excursion modules—a system that allowed astronauts to target their splashdowns from over a quarter of a million miles away. Another recent award to a '26 classmate was an I.E.E.E. medal from the Power Engineering Society to **Peter Bellaschi.** Peter has just returned from treatment at the hospital after his visit to the Lahey Center and to us and now tells us that after four weeks at home, "So far, so good."

A brief note from **Phil Robinson:** "Have been retired for 18 years. Have done consulting work for the glass industry. Spent six weeks in East Germany starting a glass tubing plant. Redesigned a roof tile plant in Corona, Calif. and, designed a complete bottle-making plant in Memphis, Tenn. Have several patents relative to glass-making. Have three married sons and three grandchildren. Still do occasional small jobs. One son has M.S. from M.I.T. . . . From **A. Howard Lane:** "Since I have been retired for about 15 years from A.T. and T. Long Lines, I have enjoyed my leisure years except for nine years (1969-1978) when I worked half days for the Village of Brewster."

A delayed notice through the Alumni Association Questionnaire reports the death of **Merle E. Hutchins** on May 7, 1981. He was a graduate student listed with our class; no further information is available.

Our son Richard called us and suggested that we join him and his wife and daughter in the little village of Puerto Escondido in southwestern Mexico. It happens that Evelyn and I spent a few days there several years ago and found a hidden, beautiful beach and fishing village unknown to tourists. So, we are off to sunny Mexico, to get away from our dismal New England weather for a few weeks.—**William Meehan,** Secretary, 191 Dorset Rd., Waban, MA 02168

27

Leroy G. Miller of Rockbridge, Ohio writes: "If you live long enough you sometimes see the fruits of your endeavors. Fifty years ago last year my wife Mildren and I established a telephone company in Indiana. It is now known as the Tri-County Telephone Co. but covers more counties. Its success has been phenomenal. My brother was in charge, and in 1960 we gave the business to him and his wife—the finest thing we have ever done! In October 1983 my brother and I and our wives were royally feted and rewarded with the most enjoyable public recognition ceremonies you can imagine. As they said, '50 years of dedication and service to the telephone industry and thoughtfulness and consideration to the customers and to the public.' It of course made us very happy. We enjoy, with occasional ups and downs, good health."

Laurence H. (Larry) Coffin writes, "On March 17, the anniversary of evacuation of Boston by the British, I am going to be married to Eleanor McNeil of Port Clinton, Ohio. She is the widow of **Gordon I. McNeil**, who died six years ago. We plan to make our homes in Ohio and North Conway, N.H. We look forward to seeing you at Pops and the class day in June." Congratulations and best wishes to you both. Larry received the Council for Advancement and Support of Education award as "Volunteer of 1983" at Maine Maritime Academy.

George D. Fexy, Kirkland, Wash. writes: "Am presently associated with the Bear Creek Country Club and its development—an 18-hole championship golf course with 300 residential lots. In my efforts to find suitable contractors, I invariably meet with M.I.T. graduates who are truly doing magnificently in their respective jobs and capacities. I met one with a heat saving company from Finland, Ekonomido, with an energy concept that saves 40 percent of heating costs."

Dr. **Maurice C. Holmes**, professor of physics, emeritus, University of Miami, forwarded a letter to **Harold Edgerton** as follows: "I think our revered and beloved mentor, Vannevar Bush, would have shared delight yesterday at seeing one of your remarkable photographs in a display of 19th and 20th century masterpieces at the Art Space Gallery in Coral Gables. Though copies of the photos, as sent by the Alumni Association have graced my desk for years, I did not know until my young guide designated you, that the eminent founder of EG&G Corp. was well known to the art world as "Papa Flash." Also, there was a fine recognition in the *Boston Globe* last fall: "Now 80, Doc Edgerton has been in a hurry all his life, and for the last 50 years has been churning out idea after idea from his lab at M.I.T. And with the same regularity, he has been turning out something just as intangible as an idea: the American entrepreneur. The students who have come

out of Edgerton's fourth floor M.I.T. lab have gone on to form dozens of high-tech companies in New England: Benthos Corp., the $4.5 million maker of underwater research equipment in Falmouth; EPC Labs in Danvers, which manufactures graphic recorders; Klein Associates, the $5 million Salem, N.H. maker of sonar equipment; and Flash Technology in Nashua, N.H., which produces strobe lights.

"And there was of course EG&G, which was started in a dumpy little office in Brookline just after World War II by Edgerton and two of his students and has grown into a high-tech conglomerate employing more than 20,000 people. What these people had in common is the things that set the entrepreneur apart—confidence, a willingness to take risks, enthusiasm and the energy to work long hours. Today some of his former students call it 'The Edgerton Factor.' "

Edgerton says, "A lot of kids come here thinking that everything's been done, that it's all in the textbooks. Well, the most important things haven't even been thought of yet. Nobody's going to tell you something original. You have got to get inspiration from the Almighty. That's the trouble now—everyone wants to be told what to do. Everybody needs strobes. The whole world is full of things going too fast to see. And I've still got a couple of lifetimes of work to do on the strobes."—**Joseph C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

28

Another ripple from our 55th reunion activities: Reading of **Ernie Knight**'s interest in and historical study of **George Chatfield**'s town of Rindge, N.H., **Walter Hildick** was inspired to write to Ernie with his own contribution to the Rindge story. In 1945 the Hildicks bought a farm in Rindge with the intention of ultimately retiring to the country. The house itself was a piece of history since the oldest part of it had been built in 1792. Walter's interest in Rindge goes back to his Boy Scout days when Lake Monomonac was a favorite camping site. This is the lake where Marie and George now live. With a change in retirement plans, Anne and Walter finally sold the farm but not before they had the enjoyment of it for a number of years. . . . We have also a note from George saying that he plans to be in Birmingham, England in June for the Rotary International Convention. He is now vice-chairman of Rotarians of Amateur Radio (ROAR) for the U.S.A., Canada, Bermuda, and "Net Control" of their two trans-Atlantic short wave networks that meet Sundays and Thursdays 1200 to 1400 GMT on 21.403 voice.

Significant honors continue to come to our outstanding classmates. **Bill Hurst** has been made a distinguished member of the Society of Petroleum Engineers of the American Institute of Mining Engineers. This is a new category in the Society, and Bill has been one of the first to be chosen. . . . A news item in the Bay State Business World for December 28, 1983 tells us that the **Hall L. Hibbard** Computer-Aided Aerospace Design Facility has been established at M.I.T. through gifts from Perkin-Elmer Corp. and CADAM, Inc., a subsidiary of Lockheed Aircraft Corp. The gifts total about $500,000, for hardware and software plus an operating fund for the first five years. The facility is named for Hall in recognition of his achievements and pioneering in an aviation career spanning the decades from wooden aircraft to earth-orbiting satellites. To both of you, gentlemen, our hearty congratulations!

A letter from **Lazare Gelin** carries a New Zealand postmark. He says, "We are now traveling through the South Pacific—New Zealand, Polynesia, etc., excluding Australia which is a continent in itself. This trip is quite different. There is much beauty in the two islands of New Zealand—it is almost incredible to see it concentrated in such a relatively small area. I am sure that many of our classmates would enjoy such a trip. It is very restful and not expensive." . . . It was a pleasure to have a year-end greeting from Virginia (Mrs. **James A.) Allan**—our honorary vice-presidents are always a joy! . . . **Jim Nargis** writes that he is still practicing architecture—mostly in churches, libraries and schools. During World War II, at Portland, Maine, he adapted some old buildings into the first open-space library and generated a lot of publicity. . . . Those of you who took classes in Course X will remember Professor Harold C. Weber who taught us thermodynamics. His death marks the passing of one of the last teaching members of that department as we knew it. We are glad that Frannie and **Jim Donovan** were in close contact with Marian Weber during Harold's final illness.

With deep regret we must report that **Fred Parker Walden** died on August 3, 1983. The information was received from his niece. Fred graduated from the Department of Chemical Engineering in fuel and gas engineering. Our record shows that he was a design and development engineer for Barrett Co. (Philadelphia and New York) prior to World War II, was a major in the U.S. Army, then a development engineer for Reichold Chemicals, Inc. (Elizabeth, N.J. and White Plains, N.Y.) in his later professional years. To Fred's family we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29 55th Reunion

Larry Moses of Sarasota, Fla. writes, "Recently, we moved into a delightful condo-villa, one of 24 units surrounding an oval-shaped village green with a pool, ramada, shuffle board, and putting green, which we recently equipped for alternate use of croquet. Our health is excellent in spite of a case of amyloidosis for me lasting two years already. Doctors of Durham, N.C. V.A. Medical Center diagnosed it in 1982 and they have successfully controlled it for these two wonderful years. I seem to be getting better each month. Kay had two eye implants and now she sees like an eagle. We had a 51st anniversary celebration and a family reunion in Blowing Rock, N.C. last August, where we spent five cool weeks. At Christmas time, my son Bill and his lovely wife, Mary, brought our only grandson, Danny (5) for a week. Also our only daughter, Kathy, and husband John Harris spent part of that same week with us. Our older son, Larry, retired as a full colonel in the regular U.S. Army, after 26 years of service. He was hired by Advance Technology and has opened an office for them in Heidelberg, Germany."

Here are some excerpts from Christmas 1983 greetings of Barbara and **George Meyers**. George retired in early spring only to discover that while they were not watching, everything that could grow did—weeds, shrubs, trees, chipmunks, and grandchildren, while everything that could wear out or get older had—house, tools, appliances, George, and Barbara. They took three trips to New England, a number of trips to Maryland and Virginia, and the fun trips to children and grandchildren were too numerous to detail. Barbara thinks life is simpler now that her two years of being president of the soroptimists are over. They are well and still play tennis, although out of it for a while due to minor injuries. They are still actively engaged in church affairs. They send their very best wishes to all. They both plan to attend our 55th reunion next June. . . . **Charles W. Sampson** of Roch, N.Y. says that he and his wife Sigrid are well and enjoying their retirement years. . . . **John D. McCaskey** of St. Joseph, Mo. sends his best wishes for health and happiness to all for 1984. He will attend the 55th at Chatham Bars Inn.

I received a note from **Robert S. Pride** of North Palm Beach, Fla. in reply to my letter of condolences on the occasion of the death of Judge Allen Ray Kingston, his brother-in-law and my attorney for a span of 40 years, as follows. "Thank you for your note concerning Ray's passing. Marion and I attended his funeral. It was quite an impressive affair with the Ancient and Honorable Artillery Co. of Massachusetts conducting the service. Marion and I are in good health, she doing her handwork and I being fairly busy with the boat and other chores. We haven't done much traveling, except a trip to Disney's EPCOT. Hope your condo builder meets his deadline better than most of them." (My wife Helen and I purchased a larger condominium in Boca Pointe Century Club in 1982 scheduled to be finished in December of that year. It was finally started in April 1983, promised for December occupancy barely finished sufficiently for us to move in on February 20. Our new address in Florida is: 7161 Promenade Dr., Apt. 502, Boca Raton, FL 33433, (305) 395-2890.)

Neal Wells of Pinellas Park, Fla. writes, "Our grandson graduated from Ithaca College in 1983, and our granddaughter graduates from Oberlin College in May 1984. Both events formed the critical points of a four-to-six week trip to the Northeast. Ceremonies at Oberlin and events at Chatham Bars Inn are perfectly timed with six days between. Otherwise our life is moderate and routine and our health stable." . . . Teddy (Mrs. **James) Fahey** writes, "I just got back from my first long trip without Jim. After flying to Texas for a brief visit in 1983 to see Jim's friends, I finally decided to go on a cruise on the Holland American Line and had a wonderful time and met some nice people, particularly two charming men from Utah. We cruised to Mexico, San Andres, Columbia, and San Blas Islands—most interesting people. Then we went through the Panama Canal, Cartugena, Aruba, and Grand Caymen. We had great weather, mostly sunny. There was great entertainment and good food."

I regret to inform you that Major General **Leslie E. Simon** who had been confined in a nursing home as an invalid without any memory, for the past two years passed away on October 28, 1983. Memorial services were held in the Garden Chapel Home for Funerals and graveside services with military honors were conducted at the Arlington National Cemetery. . . . It also grieves me to report that **Raymond Underwood** passed away on December 24, 1983 two months to the day after his wife, Freda died.

We wish to extend an apology to **Chung-Foy Yee**, whose name was misprinted in the January issue of the *Review*.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

Although most of us are now ten or more years past the classical retirement age, we still have a dwindling number of gainfully employed classmates and a few full-time workers. This month we have reports from two such classmates: **George Nakashima** is still manufacturing handcrafted furniture of his own design in his studio in New Hope, Penn. George's furniture has attracted wide-spread interest both in this country and abroad. In the last two years he has had large exhibits of his work in Philadelphia, Washington, D.C., and Tokyo. He is the recipient of a Distinguished Service Award from Bucks County, Penn., and the "Third Order of the Sacred Treasure" from the government of Japan. George's children Mira and Kevin help him with the business. Mira is married and lives in Japan with her husband and four children. . . . For many years **Bob Reynolds** was associated with the Boston-based advertising firm of Reynolds and Foster, of which he was president. About ten years ago he retired from Reynolds and Foster and began living year-round in Centerville, Mass. At that time he joined Packaging Industries Inc. of Hyannis, Mass. He was recently made administrative head and creative director of their newly-formed Communications Department with the title of vice-

president Communications.

Vince Thormin, one of our small group of clergymen, reports from Calgary, Alberta, Canada. He is no longer on the staff of the Scarboro United Church, but does considerable volunteer work "visiting sick and shut-ins in nursing homes and hospitals." He also works at the children's hospital. He and his wife are planning to visit their daughter and her family in Great Britain next summer and then go on to Oberammergau for the passion play. . . . **Irving Dow** keeps busy as the treasurer of the 898-unit cooperative in Silver Spring, Md., where he and Ruth live. He reports that **Oliver Green** lives nearby and that he and Oliver meet at weekly Kiwanis meetings. Irving also mentioned telephone conversations with **Myron Smith** and **Lou Verveer**, both of whom have recently had health problems from which they appear to have recovered. Ruth and Irving hope to combine attendance at our 55th Reunion next year with the centennial celebration of the founding of Millis, Mass., which was named for Irving's great-grandfather.

We have at hand notifications of the deaths of two more of our classmates, one of which was long delayed. It appears that **Arnold Ackiss** died in Wolfenduttel, Germany, on March 2, 1979. Unfortunately I do not have any information in my files about either his career or his family. . . . **Beverly Ottaway**, who died on October 31, 1983, worked for more than 40 years for the Mass. Dept. of Public Works including 20 years as research coordinator of the Research and Materials Division in Wellesley Hills, Mass. Bev was Secretary of the Wellesley Hills Planning Board for six years and a member of the town meeting for ten years. He was active in the Glee Club at M.I.T. and maintained his interest in singing throughout his life with engagements as a church soloist in nearly every Protestant denomination as well as at a Hebrew Temple in Brookline. As of several years ago he was musical director of the Aleppo Temple Shrine Chanters and assistant conductor of the Massachusetts Consistory Choir, as well as a member of several male quartets.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06588

31

Thanks to the Alumni Association, the following notes have been received from our classmates. Marjorie (Mrs. **E.L.) Heath** writes, "After more than four years in hospitals and nursing homes, my husband passed away in early October. . . . My activities now are mainly DAR, Mayflower Society, DCW, and OES. I am serving my 44th year as town auditor in Deering, N.H., and hope to make it 50 years." . . . **Alexander Kuhnel** writes, "Retired since December 31, 1973. Prior to retirement—staff consultant for system engineering, The Austin Co., Cleveland, Ohio. Major hobby—tutoring Grades 6 to 12 in math; 19 students at present, 15 gifted, four striving to catch up." . . . **Addis Kocher** says "Lecturer, bee keeper, lapidary/silversmith." . . . **Bob Marcus** writes "Honorary chairman of the executive committee."

Death notices were received for the following classmates: **John A. Norton; Smedley D. Butler, Jr.; Frederick A. Ritchie,** January 3, 1984; and Lieutenant Colonel **Edward H. Clouser,** September 1956. Our sincere condolences to their families.—**Edwin S. Worden,** Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John W. Swanton,** Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman,** Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

32

In October 1983 **Russell Robinson** joined the 50th year celebration of Admiral Byrd's second expedition to the Antarctic. An aeronautical engineer, Robinson's assignment was to look after the expedition's airplanes, but he spent most of his time behind dog sleds. Compared to most modern expeditions, it was extremely primitive, Robinson told the *Arizona Daily Star*. The dog teams traveled routes made treacherous by the shifts and buckles in the icy terrain, he explained. "You'd get all kinds of trail accidents," Robinson said—dogs and men injured from sled collisions. Once, a crevasse opened beneath one of the men, who would have slid to an icy death in the water if onlookers hadn't managed to rescue him.

The men lived in tents that soon became snow-covered caves. They spent 12 hours a day at work and 12 hours huddled in down-filled sleeping bags, resting and sleeping. You had to sleep stark naked to retain body heat. Imagine—23 degrees below zero, screaming and swearing as you climbed into the bag. The men soon learned that they had to bring their clothes and boots into the bag with them, to keep the clothing from freezing. . . . And the sun, which glinted off the endless plains of ice and snow, posed another danger—snow blindness.

Robinson and others received no pay for their two year's labor, just room and board and adventure. His reminiscences are filled with vivid descriptions of the land: descriptions of the frozen fog that created individual rainbows around each man. "On clear days, you could see for miles—a dog team coming over a horizon far away," he said.

Robinson left the expedition in 1935 and took a job with the Bristol Airplane Co. in Australia. He later joined the Australian air force and fought in World War II. After the war, he started his own weapons company, working first in England, then in America. Robinson retired to Tucson 11 years ago and still does consulting work, but said he spends most of this time aboard his sailboat, competing in races in Mexico.

Joseph L. Friedman writes that he has snorkeled at Bora Bora, Cancun, Playa Blanca, Kona Hawaii, and Kihei Maui. [Secretary's note: if you can identify these spots on a map you are a better man than I]. Joseph has also tried scuba diving and thinks it is great! . . . **James G. Ritchey** writes that he retired in 1977. Did some work at the Louisville Presbyterian Theological Seminary. Had some clinical training at the hospital and now is doing volunteer chaplain work. . . . **Thomas Weston** retired in December 1982 after 45 years with Winthrop Atkins Co. Inc. in Middleboro, Mass. He writes, "Rose and I are enjoying the Cardinal and Grey Society meetings since my 50th. Still playing tennis (doubles and slowly) and a mean game of cribbage. I'm jealous of **Ed Philbrick** who held a 29 hand.—I haven't done that as yet."

Mrs. **James E. Harper** writes that her husband passed away on May 8, 1983 at the National Hospital. Jimmy had advanced Parkinson's disease and his condition deteriorated rapidly in his last year. Burial was at the Arlington National Cemetery on May 20 with full military honors. Jimmy was well known among his classmates. His army work took him to many parts of the world. He always kept in touch with his classmates with many interesting notes for this column.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

What with spring coming, those 50 year graduates outdid themselves with little bits of news for fellow classmates.

There was even one letter from Barcelona. **Walter V. Skees** wrote he retired as a land surveyor in Miami after being in Venezeula with Gulf and having his own office in Miami for 25 years. He invites us to come see him: ask me for his telephone number! He reports **Ellis Littmann** as the only 1933 man he has seen since graduation.

Robert A. Dobson worked with Dobson Brothers Construction Co. in Lincoln, Neb., and now divides his time between there and California. **Joe Carbonell** writes Warren thanks for serving as our secretary for all those years. He lives in Greenville, Del.

Fred Murphy says he just couldn't resist and he and Anne sent the Whittons one of those musical Christmas cards, the first we had seen. They planned a charter sailing trip in the American Virgin Islands with the **George Stolls**. **Warren Henderson** writes that the weather was rough in Boca Raton last winter, and the influx of tourists made the streets dangerous.

Remember that outstanding basketball team of our senior year? **Bill Harper** living in Hattiesburg, Mich., now sends information from the 1933 *Technique*. "M.I.T. won ten of 12 and co-captains **Sysko** and **Feusel** with **O'Brien** were judged the outstanding players of the outstanding team of Greater Boston." Coach McCarthy was pleased with his crew. If any of you basketball players want to reminisce with other "round ball" players, drop me a note and I'll send you what addresses I have.

Harper was drafted into the War Production Board by our **Bob Kimball** and later worked on Liberty Ships. He runs Harper Research Co. but doesn't say what he researches.

In response to an inquiry about great-grand children, **Alan C. Vaughan** writes that he has five, dating back to 1979. Except for telling us that he lives in Midvale, Utah, Alan is silent about himself. There is a letter from **Abner Hopkins, V**, that I'll answer soon. Marg and **Bob Crane** threaten to stop by when they go the the Cape this spring. They have threatened before. The **George Hennings** had a good Christmas message about "belonging." **Bill Huston** has a new corporate identity: Huston Associates, Inc.—Aerospace Advisory Services.

Word comes that **Emerson Norris** of New Castle, N.H., is in good health and gets along with a walker. They have four children and eight grands. **Charles Quick**, Traverse City, Mich., wrote that he and Lynn don't ever remember a better occasion than the 50th. **Henry Somers** came to N.C. from Maine last year and didn't even call. When you come, do better.

M.I.T. has always had a policy of admitting stuudents without a choice of course. This has made for tight classes at times, but only since computer science has been added to electrical engineering has the situation become critical. Last year the faculty and administration considered various ways to restrict registration in this course. The decision since the first of the year was to make no restrictions yet. You'll be hearing about this problem. If you have grandchildren enrolling at Tech, think about it. Maybe some of you Course V men have suggestions.

If your news included on a Christmas card is just now getting into print for your classmates, don't despair—it is still new for most of us. **Joel Stevens** in Kingsport, Tenn., sent a lot of information. Arlene and **Andy Regan** have moved to a retirement home (in Kingsport?). We hope you find it as pleasant as the Whittons have for the past four years. Joel and Elizabeth went to Oregon and then to Punta Gorda, Fla. for two months. Olive and **Ray Smith** spent Christmas in N.J.

Occasionally a picture from the 50th shows up here. Stevens sent one of **Fred Murphy**, **Mal Mayer** and **Beau**. Good looking men, all of them!

All news is gratefully received, and even more gratefully received if legible. If you haven't been back to Cambridge recently, drop me a note and I'll send you an aerial postcard of the campus as it was last summer. You probably won't believe it!

We have lost several members this fall: **William L. Sheppard**, who was living in Florida; and **Arnold Fedde** a mechanical engineer who was a good amateur musician and a gyroscope expert until his retirement in 1956.—**Beaumert Whitton**, Secretary, 5150 Sharon Rd., Cottage 112, Charlotte, N.C. 28210

34 50th Reunion

I'm sorry there were no notes in the April issue but there was a good reason—I had nothing to write about. And unfortunately, there's not too much more for this one.

I have two losses to record; they both took place several years ago and came to light through the alumni directory questionnaire. We find that **Richard Fenlon** of Haverhill, Mass. died May 25, 1975 and that **Ricardo De La Torre,** of Miromar, Puerto Rico, passed away in 1979. It is always a matter of regret to me that there is so little contact with some classmates that deaths can go so long unreported.

Even the usually dependable alumni funds have slowed to a trickle. The only one I have this time is from **Ernie Massa** who says, "Am looking forward to renewing old acquaintances of 50 years ago at our reunion in June." Since this issue will be out shortly before our reunion, perhaps I may be allowed this story as a warning. The "reunioner" returned from the parties and told his wife, "Everyone was so old and fat and bald they didn't recognize me!"

With so little else to mention, perhaps I can take some space to write about the first of my trips, the eight days spent on St. Martin and Saba. Living in a summer resort as I do, I am not driven to head for the beach like a lemming. I go in fair part as a sightseer. I found the Dutch side of St. Martin reasonably attractive but being spoiled by fast development and with what I felt to be very high prices. Marigot, the capital of the French half, is small but has more atmosphere.

The little island of Saba is something else. You fly into a 1,300-foot-long airstrip. The island is all volcanic rock, and *the* road climbs immediately to the first village at about 1,500 feet. I stayed in Windwardside in a delightful little ten-room hotel, the only real one on the island. Saba has no beaches and hence attracts few tourists, which makes it great. There is scuba diving, but beyond that it's a great place to read a book, write a book, or sit and contemplate your navel. It was a delightful interlude.

The trip to India was postponed one week so that M.I.T. people could be consolidated with a group from Oregon. So these notes are written four days before I leave. The anticipation of the trip is enhanced by the fact that there will be two classmates in the party. **John Holden** from Marcos Island, Fla. will be a special addition for me, as he was part of our group in Monroe who stayed together for four years. We haven't seen each other since graduation! The other member of the class is **Wilbur Paulsen** and his wife Muriel from Dover, Mass.—**Robert M. Franklin,** Secretary, P.O. Box 1147, 620 Satucket Rd., Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35

After I listed the death of **Bill Lauder** and invited additional information about him, I received the following from Winslow H. Hartford, '30, for which I am most grateful: "Like yourself, Bill was one of my 'students' when I was an assistant in 5.01/02 laboratory from 1930 to 1933. We were colleagues for many years, and I suspect I knew Bill better than anyone in the M.I.T. community. On graduation, Bill went to work as a production engineer at the Jersey City plant of Mutual Chemical Co. After World War II, Bill retired as a lieutenant colonel and came to work in my research and development group in Baltimore, where he obtained his master's from Johns Hopkins. In 1969, early retirement caught up with us both. I came to Charlotte, N.C., to teach, and Bill went on an International Executive Service Group project to start up a new chromium chemicals plant in Leon, Guanajuato, Mexico. On completion of the plant, he was attracted by the incomparable climate and low living costs of Leon and made it his retirement home. Bill remained a bachelor all his days. He was a tremendous person intellectually and in caring for others. We'll miss the friendly note from Bill at the holiday season. I'd like to add a little to the class of 1935's bit in memory of a much-missed friend."

Through the Alumni Office comes a note from **Rollin D. Morse:** "Active in Downtown Reurbanization of Columbia, Pa., borough. Managing restoration of old church to become Columbia Museum of History. Nearly at end of term as elected borough councilman." . . . A news clip from the *Valley Press* of Bristol, Conn., has a story about our classmate **Arthur K. Deming,** who received a master's degree at M.I.T. He took on the running of the Farmington Water Co. after he retired from Hamilton-Standard, where he was plant engineer for many years. . . . Here's **Jack Holley's** latest, via the Alumni Office: "Everything fine in sunny San Diego. Wish I could say the same for the rest of the nation. My chief time-consumer these days is homespun data analysis on our ugly spending habits and propensity to tap the life savings of the elderly. My pet project is a sound currency. So far, legislators contacted are unconcerned, but I believe the move is gaining in popularity, and maybe soon they will listen. I hope to be a *great-grandfather* in April. Are there any other great-grandfathers in the class? See y'all in 1985!"

I regret announcing the death of **Arthur M. Linn** on May 2, 1983, in Sylvania, Ohio. I am sending belated condolences to his widow Doris on behalf of his classmates.

I am happy to report that Simon Relays U.S.A. is going under full head of steam and is selling its product under the name of Advanced Power Systems, the company we contracted to do the final assembly and test.—**Allan Q. Mowatt,** Secretary, 39 Congress St., Apt., 5, Nashua, N.H. 03062

36

The mailbag was almost empty this time but I do have an interesting note from **Bernard Gordon** who reports that he has retired *twice* and is now conducting his own consulting practice in "Embankment Dams and Geotechnical Engineering" in the western United States. His first retirement was in 1970 from the State of California Department of Water Resources; the second, in 1980, from Woodward-Clyde Consultants in the San Francisco Bay area. It's good to stay busy with interesting things to do. . . . Now, if some of you would get busy and write, there would be more for you to read!

Guess what? After writing and mailing the above, the next day's mail brought a letter from **Augie Mackro,** which I will share with you almost in its entirety. "Virginia and I have recently returned from a visit with our son, Jay '71, who is now living in Palo Alto, Calif. We had planned to meet Dottie and **Tony Hittl** who were also going to be in that area. However, due to a change in our plans we missed them by one day. We did call Laguna Beach and talked to them. They were leaving soon on another 28-day tour of the Orient.

"All was not lost as far as a '36 reunion was concerned. A real surprise was ahead of us. On the last day of our stay we made a visit to the Stanford University Museum of Art where we ran into Vivienne and **Eli Grossman.** That a chance meeting such as that should happen was not too improbable, as Eli the mathematician calculated, considering that we have similar tastes and habits and sons in the area. Vi and Eli were having dinner the following day in Redwood City with Virginia and **John Myers**." Augie went on to say that after attending the Mexican Fiesta they are going (and by now will have gone) on an M.I.T. Museum sponsored tour of the Netherlands and England.—**Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, CT 06091

37

Charles M. Antoni, 211-500 Lafayette Rd., Syracuse, N.Y. 13205, retired in May of 1983 as professor of civil engineering at Syracuse University. He is keeping active as a consultant on accident reconstructions. His hobbies are traveling, photography and fishing. His wife Elinor is still working in banking but plans to retire March, 1984. His daughter Lucy Chamberlain has two sons, Alan and Jeffrey and his daughter Cynthia Thomas has a daughter, Andrea. Charles writes: "My wife Lucy died in 1978 and I remarried in January 1980. Retired from S.U. in May, 1983 in time for a quadruple by-pass from which I am still recovering but even so I am vastly improved. I now have three step-sons and three step-grandchildren."

Richard C. Hutchinson, 716 Shadylane, Lakeland, Fla. 33803, is still active in his own business as a maintenance and management consultant. He is a fellow of the American Institute of Industrial Engineers and a member of the M.I.T. Educational Council since 1969. This year he made a roundabout trip (5,000 miles) to Massachusetts for his 50th High School Reunion. His daughter, Judith Hodges, has given him three grandchildren, Richard, Kimberly and Jay. **Eric Moorehead,** 223 Avenida Barbera, Sonoma, Calif. 95476, retired December, 1980 from consulting practice of structural engineering. His favorite pasttimes are gardening, swimming and traveling. His wife's main interests are gardening, golf, and travel. At the time he wrote us he was planning a second lens implant.

Bardolf A. Storaasli's new address is 3218 Oxford Dr., Durham, N.C. 27707. He retired February, 1976 after 38 years as a transformer design engineer with Allis Chalmers Mfg., West Allis, Wisc. He is now self-employed doing cabinet work and building. His hobbies are cross-country skiing, woodworking, traveling, music and gardening. Ruth who is a retired R.N. enjoys music. Their grandchildren are Jon and Jim Kirby, Mikkel Storaasli, and Olaf and Karl von Ramm. During his career he has lived in the following states: Minnesota, Wisconsin, California, Arizona and North Carolina. **Irving Sager** of 201 E. 66th St., N.Y., N.Y. retired in 1982 and was self-employed. He is now semi-retired.—**Lester M. Klashman,** Assistant Secretary, 457 Coast Blvd., #201, La-Jolla, CA 92037; **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, MA 02155

38

50th Class Gift Chairman **G. Edwin Hadley** and his bride Jean no sooner returned from Machu Pichu in Peru when he got the good news and the bad news on the first six of our to-be-record-breaking 50th reunion class gift. Good news: 191 of us contributed $140,000; bad news; we've got a long way to go.

By the time this appears in print, you will have received the announcement on our mini-reunion in June. Did you send in your reservation?

Frank Gardner sent in a note of thanks to the 45th Reunion Committee for a wonderful time. Frank is finishing the first year of a three-year term in his church governing board, on which he chairs the Christian Education Commission. . . . **Dick Henderson** was awarded an honorary membership in the American Industrial Hygiene Association for "outstanding contribution to the knowledge and practice of the profession of industrial hygiene." Dick is also doing some consulting with the E.P.A. . . . **Walt Johnson** extends a cordial invitation to all '38ers to go boating or fishing with him at Fort Myers Beach. . . . Brief note from **Lew Allen** says "retired and enjoying it."

The toughest job a class secretary has is to write obituaries, particularly for an old friend. I just learned that **T.Y. Shen** passed away in Taiwan shortly after the beginning of the year. He

had gone off on a three-day golf outing with some friends, and a few days later suffered a fatal heart attack. Ty had a company, Lien Tung, Ltd. He is survived by his wife Molly, whom he had met while at Tech, a son, a daughter, and five grandchildren.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview, Chatham, MA 02633

39 45th Reunion

Irv Peskoe was re-elected mayor of Homestead, Fla., and expects to delegate care, custody, and control of that city to others when he attends our reunion, starting June 4. Irv and **Wiley Corl** held a preliminary reunion when they met recently at an M.I.T. function in the Miami area. . . . **Charlie Hobson** retired from General Electric and is dividing his time between grandchildren, golf, and volunteer work at a nearby hospital. . . . **Dave Frankel** continues work under the Raytheon flag, and he serves as chairman of the board of its Machlett Laboratories subsidiary.

Evan Pancake retired from Texaco and bought a computer he finds helpful in administering his presidency of the Paperweight Collectors Association of America. . . . **Tom Blakistone** and Olive enjoyed a two-week visit to Egypt where they rode a boat on the Nile to the Aswan dam and rode camel-back around the Sphynx and Pyramids. . . . **Stuart Stearns** retired after a 44-year career with Merck and Co. and has started an international consulting business.

Responses to update the new alumni directory brought sad news of the deaths of three classmates: **Charles Levy**, May 28, 1983, Saratoga, Calif.; **Frank Leonard**, June 16, 1982, Cannon Beach, Ore.; and **Russell Schiffman**, September 15, 1983, Vienna, Vir. There were no details.

Seymour Sheinkopf reports that, since January, these classmates declared their intention to attend reunion: **George Cremer, Gus Hunicke, John Herlihy, Irv Peskoe, Wes Kuhrt, Woodford Thomas, Bob Casselman, Bud Venable, Bob Youngquist, Vahey Kupelian, Bill Pulver, Aaron White, Bill Brewster, Don Timbie**, and **Fred Grant**.

Subject to resolution of conflicts, these classmates also will attend: **Harold Hinman, Vija Sethaput, Nick Carr, Arthur Quint, Ruth Pitt, Alan Schrieber, Don Scully**, and **John Hamilton**.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

40

John J. Casey writes that he is looking forward to our 100th class anniversary since life is just starting down a different road for him after many years in the field of aviation. John has been named president and chief executive officer of Pan Am World Services, Inc., a subsidiary of Pan American World Airways, effective March 1. He joined the parent company in 1982 as executive vice president of operations, coming from Braniff Airways where he had served as chairman. World Services has, for the past 50 years, provided technical and management assistance to aerospace and aviation interests worldwide. Prime among its contracts are providing maintenance planning and analysis services to the U.S. Space Shuttle program and management of several airports in the U.S. and abroad.

A note from **Al Guttag** enclosed a letter received from Phyllis Blackman, widow of **Joe Blackman**. Joe died of cancer on December 11, 1983. The disease was diagnosed two years earlier, and Joe's one goal was to see his son, Timothy, graduate from Brandeis and, indeed, that he did see. Tim graduated in May, 1983, fourth in his class with highest honors in mathematics and music.

Al was appointed secretary of Course V when he graduated in 1940, and every year since then has sent cards to all the members at Christmas time. Unfortunately, almost 10 percent of the course was lost in 1983 with the deaths of **Joe Blackman, Arnie Arch** and **Leo Rainard**. Al writes that his health is still good. He ran over 2,300 miles in 1983! Age may be showing a bit since on Thanksgiving Day he won a big trophy as the oldest finisher in a "Turkey Trot." He is still a partner in patent law firm of Cushman, Darby, and Cushman.

A note sent to the Alumni Association by Adel Breitenstein indicated that **John S. Breitenstein** had died on April 14, 1983 at his home in Bethlehem, Penn. Cancer was discovered only three weeks prior to his death.

Ray Keyes wrote that he completed his professional career by terminating from Bechtel Power Corp. on WPPSS (Whoops) Nuclear Plant #2 on September 9, 1983. Income now flows through mail box without lick of work required. Work now flows through long list of unfinished home projects without lick of pay acquired. He and his wife, Virginia, still reside on the banks of the now ice-covered Yakima River near Richland, Wash. When this note appears in the *Review* it will be May and we trust that the ice will be long gone. A news clipping indicated that **John O. Lutz** was named chairman of McCord Gasket Corp., a subsidiary of Ex-Cell-O Corp., Troy, Mich. He had previously been president.

Piece of sad news from the Alumni Association offices indicates that **Paul S. Neblett** passed away on August 11, 1983 at his home in Dallas, Tex. Paul had been President of Elgin B. Robertson, Inc. No details were available.

Barrett L. Taft writes that he has "officially" retired as President of Dixie Metals, Inc., and its subsidiary, Casselberry Tire Co., located in Casselberry, Fla. however, he will continue on as part-time treasurer and consultant. Son, Scott, has taken over. Oldest son, Barrett, also in tire business is currently in France with Michelin. He plans to visit there this Spring.

Just one more year before our BIG Reunion. Be sure to put it on your calendar!—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030 (617) 785-0540

41

Nathan R. Owen will retire as chairman and chief executive officer of General Signal Corp. according to a report in *The New York Times*. **Robert Wallace Blake** writes from Seattle: "Since retiring from Pan American Airways two years ago, I set up my own small consulting operation and in addition I became a Senior Associate with Aviation Consulting Inc., Dick Speas', '40, outfit. Last February Ruth and I took my 40th anniversary Pan Am trip (use it or lose it). We spent a month on Maui and New Zealand and we were delighted to find at the University of Auckland the Richard Cockburn MacLaurin Chapel, honoring the former President of M.I.T. Bob also enclosed two clippings. The first honored **George M. White**, the architect of the Capitol, supervising a staff of 2,000 employees. He is specially commended on the beauty of the Capitol ground's gardens and for the dramatic landscaping. The second clipping features **Charley Butt** head coach of the Washington-Lee crew since 1949. His continuing enthusiasm for shells and all rowing will come as no surprise to his classmates: he eats his food with chop-sticks made in the shape of two tiny oars.

A letter came from St. George's Grenada, from **Johan M. Anderson**. Here are a few highlights of his marvellous letter, wish I could print it all. No Cubanos are hiding in the hills anymore. The American soldiers are very popular and have not gotten into trouble with the locals. Johan and his girlfriend, Barbara Stengel, were evacuated to Point Saline in a big C-130. When they came back, troops had been living in their "cave" house, but had cleaned it for them. Except for three cases of beer and two cases of shasta cola, nothing was missing. Many other houses had been looted; their maid Cecil returned after three days 20 pounds lighter and a nervous wreck. Almost everyone has faith in Sir Paul Scoon. The weather is fine, the flowers bloom and some of the soldiers swimming off the beach even wear swimming suits.

Keep your letters coming.—**J.E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

42

A note from **Jerry Coe** tells us that he has begun his second semester of teaching at the University of Bridgeport M.B.A. Program. He writes, "It's a challenge but very stimulating. I don't miss G.E. at all." **Mike Frueh** spent January through May of 1983 at the Imperial College of Science and Technology in London while on sabatical leave from his regular position in the department of geology and geophysics at the University of Connecticut. Mike says he expects to retire in three or four years.

Number One honors for this issue goes to **Milt Platt** who was selected to deliver the Edward R. Schwartz Memorial Lecture to the A.S.M.E. Textile Industries Division. He spoke on the subject, "Textile Engineering in a High Technology Age" at Raleigh, N.C. Milt also received the Smith Memorial Medal from the Textile Institute of Great Britain in December. So we get a "two-fer" for Milt Platt. Our congratulations.

Al Hayes, Mollie and their Beechcraft Bonanza have moved to Yucca, Calif. Albert Hayes & Associates, Al's consulting firm in the electronics reliability field is now eight years old and going strong. Al and Mollie have moved into their new house which they have been building for about a year. The Yucca Valley is in the high desert about 20 miles north of Palm Springs. One wouldn't believe this area: not a trace of air pollution, practically no traffic on the roads, and QUIET. If the Hayes' want to do some heavy shopping, a 35 minute drive takes them to downtown Palm Springs.

The fastest growing department of these notes is RETIREMENTS! **Al Nagel** retired from General Foods in March, 1983 and since then has been a consultant working on a U.N. Project dealing with providing potable water to the third world. **Dick Little** retired from Union Carbide and advises that the technical endeavors in the Little family have been continued by daughter Julia, a 1983 B.S.Ch.E., Summa Cum Laude from Virginia Polytechnic Institute and she was designated as the school's most outstanding engineering senior, the first time a female got that nod. Julia is now attending Harvard Medical School.

This is more in the nature of a "commercial announcement" for the M.I.T. Shakespeare Ensemble. The Ensemble presented *The Tempest* at Rye High School under the auspices of the Westchester County M.I.T. Club. The cast and crew were put up in the homes of various of our club members. Jean and I were fortunate in hosting Brian Rague '84,; Geoff Pingree '82; and Charlotte Kemp '86; who were, respectively, Alonso, Prospero and Miranda in the production. These youngsters were just great: talented, interesting, pleasant and a joy to have as guests. They were with us Friday night and Saturday night. Sat around and compared notes on drama, engineering, M.I.T., and other miscellany until the early hours of the morning with them. If any of you have an opportunity to host any of the M.I.T. Shakespeare Ensemble Players, jump at the chance.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

43

This month's news must begin sadly with two obituaries. **John Goldsmith** (Course XVI), of Palos Verdes, Calif., died August 19, 1983. John was a technical specialist with the Norair Division of Northrop Corp. in Hawthorne. He is survived by his widow. . . . **Walter H. Stenken** passed on in 1979, but we are just now finding out about it.

Walter was in the Ocean Engineering Department at M.I.T., and went on to become president of Equipment Consultants, Inc., South Ft. Mitchell, Ky. Survivors are unknown.

Jim Reswick favors us with a copy of his Annual Letter to Friends and Relations, which I have mined for several nuggets. Jim has recently been appointed director of the Veterans Administration Rehabilitation Research and Development Evaluation Unit in Washington, D.C. His job is to make more and better technical devices available to handicapped persons. Travels included a couple of trips to Germany to visit wife Trudy's parents, and an excursion to Tunis, where they acquired an assortment of hand-woven textiles for their collection, and then had a blood-curdling escape from an explosion of native rioting over high food prices. The letter also reports the activities of an indeterminate number of children and other relatives scattered from California to Turkey, plus a fun-loving golden retriever. The Reswicks live on Dead Run Drive in McLean, Va.

Friends, I can't write it if you don't send it.—**Bob Rorschach,** Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44 40th Reunion

Arthur Gray, Jr. is president and CEO of Dreyfus Personal Management, Inc. Art began his investment career at Kuhn Loeb and Co., then founded his own New York Stock Exchange member firm, Gray and Co., serving investment advisory clients for 15 years as the firm's senior partner. Among other activities, he has served on the Hudson Institute's Prospects for Mankind Advisory Board; as a director and co-chairman of the finance committee of the American Arbitration Association; as a director of the International Center for the Disabled; and as a trustee of the American Museum of Natural History. . . . A new journal, *Hazardous Waste,* edited by **Norman Beecher** of Tufts University hopes "to establish industrial waste technology as a firm scientific and engineering discipline. It will serve as the central source for the dissemination of information, for the purpose of advancing technology and, ultimately, of providing economical and ecological methodology for the regulation and management of hazardous waste."

Word has been received of the deaths of **Harold W. Rambusch, Jr.,** sometime in 1980; **Jules L. Lobsitz,** June 30, 1983; and **Reynold F. Gamundi,** January 17, 1984. We shall also especially miss Elvira (Peinado), wife of **Arturo M. Morales Dominguez,** who died on January 13, 1984. Elvira rarely missed a class reunion and joined us during Fiesta in Mexico last year. Our deepest sympathies go the surviving members of these families.

Robert J. Horn, Jr. was married on October 3, 1983 to Dr. Bohumila B. Ptak, a Czechoslovakian M.D. practicing in West Germany. Bo expects to join R.J. in this country this summer. Congratulations! . . . Have a good summer and keep the news of you coming to me for the class notes—**Melissa Teixeira,** Secretary, 92 Webster Park, West Newton, MA 02165

45

Yes, in another 12 months we will be celebrating our 40th reunion. It is hard to believe or remember that a limited few threadbare civilians and an incongruous lot in white bell-bottoms (but what a glorious group!) journeyed across the Charles to New England Hall to receive diplomas some 39 years ago. Your 40th reunion committee has started the planning process—you know MBO and all that jazz—but the results will be there! Plan now to join in revelry and memorabilia in early June 1985. Details will follow in rapid fashion. And with a 40th reunion goes a 40 year gift; that is, all those monies we have contributed—don't forget those matching gifts—in 1981-85, as well as any commitment or pledges made in 1984 or 1985 to be paid off by the 1988 fund year. **Chris Boland** is our gift chairman with yours truly and **Jim Levitan** aiding the cause as vice-chairman. Seed meetings were held in Cambridge and New York in the fall, whereas the committee and its goal were formally kicked off at a bash in Cambridge on March 13.

Yes, it has been about a year since you have blessed me and your classmates with sufficient news for a meaningful column. Here we go. **Larry VanIngen** advises that he is still with Mobil in New York City after 37 years. All four children are out of college and working successfully. He hopes to make the 40th in 1985. . . . **Ed Stoltz** had a good year financially and healthwise. He retired a couple of years ago from Johns Manville and now consults. Ed says, "Elinor and I took several trips to various sections of the U.S. complete with golf clubs. We managed to play golf three or four times per week. We took our 'Elderhostel' course at Dickerson State College in North Dakota to learn about Medora, the immigration of Indian tribes and their geographical influences. 'Elderhostel,' for those over 60 years, is headquartered in Boston. . . . **Hedley V. Patterson,** still located in the Woonsocket, R.I. area, indicates that he has just completed a year as president of the Rhode Island Society of Professional Engineers and a year as vice-president of the Rhode Island Water Works Association.

Edna and **J.J. Strnad**'s Christmas card, as always was another Edna work of art. If JJ had a beard, he could be Santa Claus, as he continues to have a full head of hair, now all white! . . . **Jerry Patterson** continues his Dallas commute while Libby's horse business thrives; she now stables 19 horses! The next two Patterson generations are spread between New York and Portland, Ore., with Tony and family just around the corner in Dallas. . . . **George Hetrick** and family continue in Lancaster, Pa. deeply involved in a recovering housing market; yes, GB is a home builder.

Ep Radner is president, GCA Corp. in Boston. . . . **William A. Loeb** is president of West Stockbridge Enterprises, Inc., an energy engineering firm specializing in small hydroelectric plants and computerized facility control systems. When one considers that New England has 8,307 existing dams plus 1,445 breached dams, and only 363 operating hydro dams, Bill is about to put the nuke out of business. . . . **Lloyd Balsam** retired from Northrup Electronics in early 1981 after 34 years; Lloyd is now a Los Angeles based management consultant in the military aerospace arena. . . . After 26 years of Boston practice, Dr. **Frank Bates**, an orthopedic surgeon, joined the medical staff at Huggins Hospital in Wolfeboro, N.H. in early 1983. He sees patients on Mondays, Tuesdays, and Thursdays, and devotes the balance of his time to photography, forest management, and horticulture.

Nick Mumford continues to spend the bulk of his retirement working for the local Episcopal Diocese north of Detroit; his work continues fascinating and frustrating but fun. Nick's family is spread from coast to coast with son Rob and bride in Portland, Ore.; Lis and husband nearby; son Nick and brood in Baltimore; and Ayliffe back in Boston after two years in Michigan. The Mumfords will be at our 40th, as will Mary and **Jim Hoaglund**. Jim continues as chairman and CEO at McQuay, Inc. (Perfex dropped from name in 1983). Unfortunately, Jim's 1983—as it has been for all too many of us—was not too healthy.—**Clinton H. Springer,** Secretary, Box 288, New Castle, NH 03854

46

Got a folder full of material from **Bob Nelson,** one of our far-flung Course VIers, working now at China Lake Naval Ordnance Test Station and living "next door" in Ridgecrest, Calif., on the tippy southeast side of the Sierra Nevada. Included with his note was a color-filled ten-page, single-spaced account of his week-long trek last July into the Golden Trout Wilderness Area, a little south of Mt. Whitney. When Bob isn't hiking or working, he pedals his bike (8,000 miles in four-and-one-half years) to keep in shape. He claims he got the hiking bug clear back in 1944 when he, **Gene Bockhorst, Bill Siebert, John Wandrisco,** "and others," hiked up/on/near the Appalachian Trail in the White Mountains and climbed Mt. Washington. Now wasn't *that* a swell way to start! Keep on trekkin' there, Bob.

A three-liner from **Al Kent,** yet another V-12 XVIer, reveals that he as retired from the retail fuel oil business in upstate New Jersey, still living in West Orange and working with the Sierra Club on the New Jersey Bottle Bill campaign. Fellow New Jersey Alumni can help by calling him, (201) 731-1765.

A slight correction to the February/March notes in that **Don Burke** wasn't on his way to Hawaii. Would you believe *Australia*! He must have made friends, 'cause, he claims, some M.I.T.ers helped the Aussies win the Americas Cup last fall, making "a lot of folks happy . . . for sure, mate"! He goes on to say he's heard from other '46ers: **Dick Krahe** (in Baltimore), **Jack Harvell** (in Sudbury, Mass.), and **Bob Striker** (in Port Washington, N.Y.). Don and **Don Robinson,** his St. Pete "neighbor," are co-chairing the 40th reunion gift drive for Florida, and they "look forward to meeting some of our buddies and friends as the months pass." Also, living near Tampa, he says "we can always put up '46er Super Bowl attenders, but don't ask for tickets. Ask Pete Rozelle where they all went." (I just read where the Tampa Bandits might outdraw the Buc's this year. So Nya-a-a-a-h to you, Rozelle.)

Another supportive note from **Bill Cahill,** just before his leaving for New Zealand, we gather February 1, 1984. He's afraid we're all backing into our sixties, too scared to look. "What happened to touch football, skiing, hang gliding," [and jive-'til-five]? He was also nice enough to forward a letter from **Jim Chabot** (pounded out on a IBM PC yuckitty yuck). Jim's elder daughter is about to finish med school at New York University, and "that should do it, but I've thought that before." He's "into" golf, going to a school in Florida in April, hoping Bill might join him, or other way around, later visiting Bill in Incline Village for some 10K-high-ball.

Jim recalled the Pax River bunch in '46 (**Jim Corbett, Larry Body,** and themselves) "trying to play golf at some course in Washington." Now that must have been an eye-splitting sight.

Roger, over, and out!!—**Jim Ray,** 2520 S. Ivanhoe Pl., Denver, CO 80222

49 35th Reunion

Ingram Lee has been with Texas Instruments in Dallas for 35 years, and is now manager, material management services, mostly involved with the corporate transportation system. He is also director of the Texas State Rifle Association and active in competitive rifle shooting, although he finds that the "600-and 1,000-yard targets get smaller every year." . . . **Harold McInnes** is president of AMP, Inc., and has been appointed director of Sanders Associates. . . . Two of our classmates have been promoted to chief executive officer of their respective companies: **Dwight Hibbard,** of Cincinnati Bell, and **Richard Morel,** of Boston's Algonquin Gas Transmission Co.

Dave Keniston plans to retire in 1984 from Jones and Lamson Co., and is looking forward to our 35th Reunion. . . . **Herbert Federhen** has retired from the Army after 30 years, but has stayed in Arlington, Va., and is now with the Institute for Defense Analyses. . . . **Frank Finnegan** has retired from IBM Federal Systems Division and has joined Vitro Corp. to establish a regional marketing office in Jacksonville. Frank and Jan will be living in Ponte Vedra Beach. . . . The retired ones still keep busy: We have heard from **Orlien**

Becker that he has not forgotten his professional skills, having conducted a two-day seminar in energy management for building managers. . . . With regret, we report the death of **Francis Marran** in March 1981.—**Paul E. Weamer,** Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017 (314) 576-9919

50

Since the beginning of this year, **Claus G. Manasse** has been working at Astradyne Computer Industries in Garden City, N.Y., as chief financial officer. The company is engaged in providing data processing services for banks and in a variety of services for health care institutions. Claus's son, Michael, is 15 and attends Ridgewood High School; his daughter, Karen, is 13 and in junior high school.

Since May of 1980, **Albert J. Romano** has been a senior program manager for space/satellite equipment in the aerospace electronics office of the Motorola government electronics group in Scottsdale, Ariz. On January 1 of this year, he joined the Motorola G.E.G., international operations as international (world-wide) products marketing manager. . . . **Paul M. Zorn** plans to retire early from high school chemistry teaching this June. **Vinson R. "Bud" Simpson** has just completed three years of owning and managing his own manufacturing company: Marion Body Works, Inc. of Marion, Wisc. Bud says it has been highly rewarding, not just financially, but for the satisfaction of molding a free enterprise company of some 75 people into a high quality, customer responsible, high-value-producing entity with earned pride. His company makes all-aluminum body fire trucks and emergency vehicles, refrigerated truck bodies, military cargo bodies, beverage van bodies, and enclosures for telecommunication gear. Each item of business requires close engineering contact with the customers.

Richard Nelson Bolles of Walnut Creek, Calif., and author of the best-selling book *What Color is Your Parachute?* is at the peak of his chosen field and well-to-do going on rich. The first publisher of his work was the photocopying machine in his office, and many a copy was given away rather than sold. He can remember being so broke on a Friday in 1971, that he faced a weekend with $5.18 in his pocket. He offered up prayers for a few sales of *Parachute*, and was answered by an order in the afternoon mail and a personal visit from another buyer. In 1972, he turned publication of the book over to Ten Speed Press of Berkeley, Calif.; it was becoming clear that he could no longer handle the paperwork. Without quite realizing it, he had written a colossal best seller. Since 1972, in a vivid measure of the urgency Americans have about changing careers, *Parachute* has been through 29 printings, and sold 1.3 million copies. It has been on *The New York Times* paperback best seller list since 1975. Bolles has produced two other books since *Parachute*, and although neither rivals its sales, they have sold far beyond what is deemed respectable in the publishing business. The first was *Where Do I Go From Here With My Life?* (with John C. Crystal, A Continuum Book/The Seabury Press, New York, 1974), followed by *The Three Boxes of Life, and How to Get Out of Them* (Ten Speed Press, 1978). The 1984 edition of *Parachute* is in the bookstores now. Dick is presently working on a book about "relationships."

It is with sadness that we announce the deaths of **Raymond C. Gardner** who passed away on May 4, 1981; and Dr. **John J. McHugh** who died on November 1, 1983. Our condolences to their families.—**John T. McKenna, Jr.**, Secretary, One Emerson Place, 11-H, Boston, MA 02114

51

Tracy Wichmann writes, "In 1978 I gave up the tumultous career of a consultant for steady work at Hughes Aircraft Co., where I am paid well for doing purely technical things. I miss the tax benefits but not the anxiety of wondering where that next client is. In 1979 I was widowed. As soon as I recovered, I drifted into a kind of wild single life, but quickly tired. I met and married a very attractive widow, and we are exceptionally happy. We have a 28-foot cruiser, and my hobby is repairing the starboard engine. If it runs, I enter predicted log races where we try to pass a set of specified marks according to our predicted schedule without a watch." . . . **Louis G. Sylvia, Jr.** retired from E.I. duPont deNemours and Co. on November 30, 1983 after 32 and a half years. He plans to do engineering consulting work for the near future and eventually relocate to the East Coast. . . . **I. Victor Yancey** reports he is still employed at Aeronautical Systems Division at Wright-Patterson Air Force Base, Ohio, heading the Flight Systems Engineering Division, which supports a number of program offices for tactical aircraft and missiles. He also is president of the board of trustees for a rural water system serving 1,000 families and member of the board of directors of the Western Ohio Chapter of the Society for Advancement of Management.

John C. Lowry still lives in Chappaqua, N.Y. His last child (a daughter, 16) will leave next year. One of his older two daughters is at Princeton, and one graduated from Mt. Holyoke. John now is vice-president of Trinity Paper and Plastics, a company purchased in leveraged buy-out during 1983 by a group of inside and outside investors. . . . **Donald L. Brown** writes that he visited **Kevin Borcant** in Trinidad. Kevin is very active professionally and has one son attending M.I.T. and another who graduated from M.I.T. Donald designed Reynolds International's largest two-story aluminum building in Coriva, Trinidad. . . . **Jurgen Elkan** retired from GTE Laboratories two years ago and is working as a consultant in telecommunications now. . . . **William A. Krampert** retired from Mountain Medical Equipment in April 1983 and is now doing part-time consulting in the Denver area.

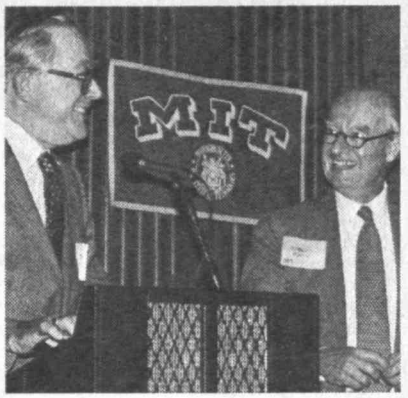
We regret to report the death of **Alfred Sudhalter** on December 20, 1980.—**Gregor J. Gentleman**, Secretary, 600 Holcomb, Suite 1, Des Moines, IA 50313

52

In his note for the benefit of this column, **Werner Kahn** begins promisingly by saying that he retired from Gulf Oil in March, 1983, but immediately spoils the picture by going on to say that he has set up his own company, Southern American Services Corp., in addition to being on retainer to Gulf. His firm promotes exports of Brazilian-made auto parts and foundry castings. He says he is making good progress, and is busier than ever, which is a sort of progress, I suppose.

Dick Lyle is another man who mentions retirement, but doesn't really mean it. He writes, "Am still enjoying my assignment as vice-president, Oronite Additives, Geneva. Retired from the Army Reserve in August, 1983 as a colonel. Was awarded the Legion of Merit and the Distinguished Service Medal for my work on Army staff. Will miss my 'second career.' Had the pleasure of seeing my daughter Marilee graduate last May in Course II." Congratulations on the decorations, Dick. Too bad they didn't award you a few pronouns.

Two others who toil in Chevron's vineyards are **James Strawn** and **Nick Haritatos**. Jim is currently division manager for Chevron's mid-continent exploration division. He was general chairman of the Society of Exploration Geophysicists' annual meeting in Las Vegas last September. He says that gave him the privilege of chairing the awards and music program held during the meeting and helping to hand out honorary membership awards to Enders Robinson, Sven Treitel, and David Strangway, all with M.I.T. Course XII backgrounds. Nick has been working on synthetic fuels and fertilizers during the last year. His team helped build and operate a tar sands pilot plant in Colorado, and provided process support for the startup of a fuel ethanol plant in Kentucky. His son spent last summer at Tanglewood, and his daughter spent two weeks in Germany on tour with the San Francisco Girls Chorus.



His 1983 Bronze Beaver—highest award for service of the Alumni Association—was given to George M. Keller, '48 (left), by Robert W. Mann, '50, president of the Alumni Association, in San Francisco early this year. Keller was cited for volunteer leadership "truly remarkable in depth and breadth" over more than 20 years—"willing, competent" service that has represented "a key leadership role." **(Photo: Philip L. Molten, '55)**

Kaspar Habosian died suddenly of a heart attack January 16, 1984 at his home in Watertown, Mass. His early life seems to have been interesting, in the Chinese sense, for he was born in Khoj, Iran in 1926 and grew up in Kiev, U.S.S.R., and during World War II he did forced labor for both the Russians and the Germans. Escaping after the war to Vienna, he studied electrical engineering there at the Technische Hochschule for two years before completing his education at M.I.T. After service in the army, in 1954 he went to work for Baird-Atomic, where he specialized in the development of spectrographic instruments for space, military, and commercial applications. He worked there for the rest of his life. He held the title of chief engineer since 1965. He is survived by his wife, Madeline, a son, three daughters, his parents, and a sister. **Art Turner**, his colleague at Baird, kindly forwarded this information. In his covering letter, Art said, "Kaspar was a remarkable fellow; we're going to miss him at Baird. He could always be counted on to bring a dry-as-dust meeting to life by saying the things that had to be said." Art also said, explaining the trouble he had taken, that in his experience as class secretary, the hardest thing to do was the writing of obituaries, particularly with little in the way of facts. That is certainly true, and I am grateful to Art for his thoughtful help.—**Richard E. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

53

Many of us are at the age where our children are getting married and/or presenting us with grandchildren (and we're all so young, too!). **Dick**

Linde writes from New Jersey that his son, Mark, tied the connubial knot in November 1983, and that two of **Fred Cronin**'s children were also married last year—son David in May and daughter Suzanne in September. Dick reports that he's still with Western Union, where he's now managing worldwide *TELEX* services, developing several new services, and enjoying the challenge that his work represents. . . . **James R. Sullivan**, who is with IBM Manufacturing Technology Institute in New York, N.Y., has two grandchildren, Margaret and Max. . . . Another of our classmates with IBM, **Donald J. Jongbloed**, writes that he has been procurement manager in Seoul, Korea, since September 1982; he heads the international procurement office for IBM/Korea. He points out that Seoul, with a population of 9 million, is the world's fourth largest city. . . . A note from **David N. Keast** informs us that he is now a vice-president of HMM Associates, a small engineering consulting firm in Concord, Mass., and that his eldest son is a graduate student at M.I.T. in the Architecture Machine Group. . . . From a news release, we learn that **J. Charles Forman**, who lives in Darien, Conn., was appointed to a sixth term as secretary of the American Institute of Chemical Engineers, the 60,000-member technical society which he has also served as executive director since 1978.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

54 30th Reunion

It's not too late. . . . come to the 30th reunion, June 7-10. The fare includes the traditional M.I.T. night as the Pops, an old-fashioned New England clambake, a champagne reception at the president's house, etc., etc. Come to our panel discussion on change-of-life career changes. See first hand how, 'though you maintain your youthful vim and vigor, the rest of us have aged.'

Speaking of age, I am pleased to report that **H. Richard Crowther** is the proud grandfather of Ali Katherine, circa 9 months. Richard is now executive vice-president of Illinois Tool Works.

Rumor has it that our reunion chairman, **Gramps Warshawer**, is an expectant grandfather. E.T.A. is reunion weekend. When Bob plans a reunion he goes all out! Bob's wife Natalie recently had an exhibition of her prints at the Francesca Anderson Gallery on Newbury Street.

Gerald Golden is manager, materials characterization and processing, at the United Technologies Research Center. Gerry is the proud father of two married daughters and a third daughter whose marriage is scheduled for August. Sounds like an old TV series.

Harry Taylor writes from Israel that his daughter Alisa is married and living in Austin, Tex. Harry also has children, Maya and Lior, ages 5 and 8 . . . never knew they had such long winters in Israel.

It will be a "long winter" for you if you don't make it to the reunion. There won't be another opportunity till 1989, so we hope to see you all in June.—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Samna**, 28 Chestnut Hill Rd., Groton, MA 01450

56

Martin O. Saltarelli, a Pittsfield, Mass. native, has been named vice-president of international marketing for the pulp and paper systems group of the Beloit Corp. In his new position, he is responsible for marketing five of Beloit's product lines. Most recently, Saltarelli was general manager of the Beloit-Rauma operation in Campines, Brazil. He joined the Jones Division of the Beloit Corp. in 1956 as controls engineer and advanced to senior vice-president of marketing, sales and engineering before taking the job in Brazil. . . . From the *Berkshire Eagle* comes a newsclip about **Murray A. Gerber**, president of Prototype and Plastic Mold Co. of Middletown, Conn. Prototype acquired Appalachian Engineering of Pittsfield, their second acquisition in 1983. In May, Prototype bought Trans World Consultants of Windsor Locks, Conn., a small competitor whose operations Gerber consolidated into his Middletown facility. Prototype is a growing concern that employs 94 people in Middletown, and "is going to be a $2 million company in a very short time," Gerber says.

From **Jerome E. Vielehr** comes this note: "Enjoying my early retirement, including winters in Wisconsin. No plans to move to Florida or Arizona." As I sit and shiver in Denver, I'm glad to see that someone enjoys the cold weather. . . . **Franklin T. Flaherty** writes to tell us that his family has bought their first new car in ten years, and their neighbors gave them a party in honor of improving the neighborhood.

Lawrence Moss and family were visited by a television film crew from the program "A House for All Seasons," a 13-week series on making homes more energy-efficient. The Mosses' segment appears at the end of the final program of the series. When the interviewer asked how the house is heated during extended periods of cold, cloudy weather, Larry introduced Anne (about 70 watts), Joshua (40 watts) and Elizabeth (30 watts)—along with waste heat from lights and appliances, they are all that is needed to do the job. Larry reports that most of his current energy design work is with much bigger buildings, where the potential operating cost savings can be very great. As an example, a project in Washington, D.C., will use storage of heat and cold, an innovative ice-making technology, special glazing materials, and high-efficiency lighting systems to reduce annual energy operating cost from about $600,000 to $215,000. Larry has been elected to fill the director-at-large seat on the executive committee of the Gas Research Institute; he says, "In my previous experience with G.R.I., I've developed a high regard for the people associated with it and for the research it funds, so I'm looking forward to serving it in this additional capacity." Larry and Anne welcome visits from classmates to their Estes Park home.—Co-secretaries: **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818; **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345

57

Ralph Warburton, professor at the University of Miami, has received two statewide awards for his work as a consultant to the city of Coral Gables in preparing a redevelopment program for the Biltmore Tower. An honor award for outstanding preservation was presented by the Florida Trust for Historic Preservation, and an award of excellence was presented by the Florida Chapter of the American Planning Association at their annual conference in Orlando. Ralph has been a member of the University of Miami faculty since 1972. He previously served as special assistant to the Secretary of Housing and Urban Development in Washington, D.C. He also currently serves as president of the University of Miami Chapter of Sigma Xi, president of the Yale University Planning Alumni Association, and member of the Editorial Advisory Board of the *Journal of the American Planning Association.*

Edward A. Friedman, dean of the college of Stevens Institute of Technology, has been promoted to vice-president for academic affairs. During his tenure at Stevens, he served as a visiting professor at Kabul University in Afghanistan and returned later to direct the development of the university's engineering college. He was awarded Kabul University's citation for outstanding service as well as the highest educational medal of the government of Afghanistan. He is currently senior vice-president of the Afghanistan Relief Committee. A national proponent of increasing public understanding of the role of technology in modern society, Friedman has written numerous articles and is founder and past chairman of the Council for the Understanding of Technology in Human Affairs. He is co-editor of *Machine-Mediated Learning*, an international journal addressing scientific, technological, and management aspects of the application of machines to training and instruction. In 1971, he was co-winner of the Stevens research award for experimental laser studies of polymers. He was awarded the honorary degree of master of engineering by Stevens in September at the college's opening convocation ceremony.

An article in the September 27, 1983 issue of *USA Today* featured **Edward B. Roberts**, M.I.T. Sloan School of Business professor and director of M.I.T.'s program in the management of technology. Unique among the hundreds of business and engineering schools, M.I.T. has the only autonomous program run jointly by a school of engineering and a school of business.

Bernard L. Wexler has joined the Kellogg Co. as vice-president of corporate information services. He was previously employed for 24 years by General Electric Co., most recently as manager of the corporate information processing operation for the telecommunications and information processing operation in Schenectady, N.Y. Wexler holds B.S. degrees in mechanical engineering and business administration from M.I.T. and an M.B.A. from M.I.T.'s Sloan School of Industrial Management.

It is with deep regret that I report the deaths of two of our classmates. **Alexander Penchuk** died in February 1983. His wife Natalie may be reached at 22 Curtis Rd., Natick, MA 01760. . . . **Philip T. Andrews** died in March 1983, and his family's address is 20 Gunderson Rd., Wilmington, MA 01887.—**Vivian Warren**, 156 Northrop Rd., Woodbridge, CT 06525

59 25th Reunion

Our reunion rapidly approaches. Any of you who have not made your reservations should hurry or you will be out of luck. I can still recall the delicious lobster from the 20th reunion, and I am looking forward to all of the new memories that will carry me from the 25th to the 30th reunion.

News from classmates indicates that IBM has recently promoted **James Forese** from controller to corporate vice-president. . . . **Tom Crystal** advises that he has recently been elected vice president of the Acoustics Speech and Signal Processing Society of the IEEE. He is also chairman of the society's conference board. Not having suffered enough at the hands of the institute, Tom has allowed his son, now a sophomore in computer science also to be entrapped. . . . A note received from **Bill Barr** indicates that he is the principle scientist at the Bettis Atomic Power Laboratory. Unfortunately, Bill has not indicated where that is located or with what kind of atomic power projects they work. . . . **Dave Pawliger,** a doctor specializing in internal medicine, hematology, and oncology, is still flying a plane, so if you get sick in some inaccessible place, maybe Dave can fly in to save you. . . . **Bradford Bates** writes from Detroit that he is now the president of the Detroit M.I.T. Club.

As far as yours truly is concerned, my law firm recently moved from 90 Broad St. in New York to 2 Park Ave. We now have six attorneys and do a lot of work in computer law, litigation, and taxes. Our new offices are quite comfortable and the view, while not breathtaking, is pleasant. As I gaze out of my window, I am able to look at a number of gargoyle-like features on the building across the street, framed in the background by the Pan Am building.—**George L. Barnett,** Acting Secretary, 2 Park Ave., New York,N.Y. 10016, (212) 686-7700

61

My profound apologies for missing the last couple of columns. My excuse is travel out of the country, including a wonderful time in Egypt over the Christmas and New Year's holidays. Egypt should appeal to anyone with a bit of wanderlust in his heart. The antiquities in Upper Egypt are as fresh and lovely as the most modern art. Wandering through ruins and tombs made me realize how recent these civilizations really were. It often seemed as though the painter had just stepped out for a moment to let we tourists see the progress of his work. An even more pleasant surprise was modern Egypt. It is, to be sure, a "developing" country, with problems of over-population, health and literacy. But I saw none of the grinding poverty common 20 years ago. The people we met were consistently friendly, honest and fascinating. I have several "pen-pals" as reminders of the trip. My sole regret was only planning a two-week trip.

Getting to the material accumulated over the last few months, I am struck by the remarkable breadth of achievement in our class. We seem to have classmates in every nook of the world. . . . **Tom Traylor** is president of Traylor Brothers, Inc., whose most recent project was the tunnel works for the Singapore Subway. . . . **Henry Gabelnick** writes that he is "still traveling all over the world looking for a better contraceptive." This cryptic statement becomes clearer when one recalls that Henry works for the N.I.H. on a large contraceptive program. . . . **Bill Jouris** writes, "After seven and a half years in Saudi Arabia, the project I came to work on is almost finished. Now for operations! The Cancer Therapy Institute will have its grand opening before the end of 1983. The gamma processing facility, which I head, will hopefully be completed and operational by the end of November. After it opens we shall start irradiating supplies for the hospital. We have a great team for building research centers. Anybody out there got a new challenge! Peking, maybe?" . . . **Avram Kalisky** is a manager and partner of ESHEL Consulting, Planning and Management, Ltd. They provide consulting services for high-technology companies in things like marketing, research and development, management, financial and administrative services. They have a subsidiary, Ma'arakhot Ergocom, Ltd., which is involved in Israel-Canadian trade; **Robert Logan** is an associate in this part of the firm and is based in Toronto. Avram also owns The Microcomputer Center—a company selling computer software, hardware and services to the Jerusalem business community.

Terry Langendoen writes that he has been elected secretary-treasurer of the Linguistics Society of America, effective January 1984. This spring he coauthored a book with Paul Postal, *The Vastness of Natural Languages*, published by Basil Blackwell, Oxford. . . . **Marshall Greenspan** has been appointed to a National Academy of Sciences Air Force Studies Board working on advanced airborne surveillance radar. . . . **Dewey Ryu** writes, "I have moved to the University of California, Davis, where I have a joint appointment in the Department of Chemical Engineering and the Department of Viticulture and Enology with an endowed chair professorship—the Maynard Amerine professor of biochemical engineering."

Next issue, I'll bring you up to date on the activities of the class governor: **John Sununu** of New Hampshire. We are deluged with clippings about him every month, and he seems to be doing very well. 'Til then, please keep up the writing.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

62

Herbert Ayres is chairman of Ayers, Barry Corp., founded in 1980. The company provides advice to financial institutions on such things as management of employee benefit funds. . . . **Richard Clayton** is now vice-president, product development of Thinking Machines, Inc., in Waltham. . . . **Robert Covey** is a member of the technical staff at RCA Laboratories in Princeton. His research is in diffraction theory and in video optical and stylus recording.. He has two patents pending, a conference paper published, and an article to appear in *Applied Optics*. . . . **Keith Ferguson** is still with the Santa Clara Division of Hewlett Packard, but is now research and development engineering support manager—also known as "productivity guru." He is also busy with square dancing.

Edward Feustel writes that he would like to hear from other East Campus residents from our era. . . . **Erich Ippen** has been chosen a fellow in the I.E.E.E. for his contributions to pico-second optics and optical instrumentation. . . . **Stan Jacobs** has by now returned from the Antarctic, where he led a group of scientists on a study of ocean heat flux. He is currently a senior staff associate at Columbia University's Lamont-Doherty Geological Observatory. Stan is married with one child; he lives on the Hudson River in Piermont, N.Y., where he chaired the local planning board and is renovating a couple of elderly houses. . . . **Terry Kohler** is listed in a newsclipping as chairman of North Sails, Inc., in addition to being chairman of Vollrath Co. . . . **Ruth Nelson** is back with G.T.E. in data communications, managing a group of systems engineers. Her daughter Diane is in Australia as a high school exchange student, and Ruth and her son David plan to visit. . . . **Darold Rorabacher** is still at Sanders Associates in Nashua, N.H. He is now vice-president, chief engineer of Surveillance Systems Division, on which he comments, "Imagine that, and me a Course XVIII graduate."

Lawrence Salba is director of information resource management for the Bendix Automotive Sector of Allied Corp. . . . **David Spencer** writes that after Datalog was merged into Litton, he spent a short stint as president of Muirhead N.A. But the entrepreneurial bug got him and Data Recording Systems was born in February 1983. It involves laser scribe development—a plain paper typographical printer. He says the work is exciting but he's putting in a lot of time. . . . A brochure from the M.I.T. Club of Northern California mentions **David Stare**, owner of Dry Creek Vineyard of Healdsburg. He provided the wines for a party for the club. . . . **Theodore Sheskin** was a 1983 NASA/A.S.E.E. summer faculty fellow at Stanford in Autonomy and the Human Element in Space. He wrote papers on the commercialization of a space station and an unmanned platform as an initial capability in space. . . . **Jeff Steinfeld** has assumed co-editorship of *Spectrochimica Acta, Part (A)* and is looking for good manuscripts. . . . **Daniel Thornhill** works at Intermetrics and owns a house in Arlington. He visited **John Stanley** in Quito, Ecuador, last spring.—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

I expect that by the time you read this the Orioles will be leading the American League East to stay. That puts me in the right frame of mind to pass some news. First, I want to thank those of you who have been sending in notes with your contributions—I don't have to spend column space on my philosophy, and the 'tute gets some bucks! Keep it up.

Here we go: **Dave Mehlin** is living in Marblehead, Mass., and recently joined the architectural firm of Priestly/Sterling, Inc. as vice president. Another architect, **George Bryant,** lives in Provincetown, Mass., with his wife, Rosemary, and two-year-old son, Ethan. George is a town selectman (selectperson?).

Are you a collector? **John Brach** is. He collects circulated pennies and transit tokens, and has for 20 years. He would like to trade; write him at 4618 Dellrose Dr., Dunwoody, GA 30338. . . . **Elliot Bird** ran the Philadelphia marathon last Thanksgiving, in 3 hours, 26 minutes, 13 seconds. He *alleges* he lost two minutes at the start because of crowding. (Elliot: if you run faster, you can get out in front of the crowd. Of course, I'm no one to talk—I doubt I could run a marathon in three days.) Elliot will have spoken (the transport delay in this column makes for strange tenses) in April in San Francisco at the annual meeting of the National Council of Teachers of Mathematics, on teaching problem solving in elementary schools.

Living in San Francisco is **Joel Schindall,** who moved there 16 years ago, just to try it out. (It's the same story with me here in Baltimore, " 'Frisco on the Chesapeake.") He works at Watkins-Johnson, currently managing its product-development department. Joel finally broke down and got married in 1979 (heck, most of us are already on No. 2), and now has a year-old daughter named Katie. Says she's smarter than he is.

Steve Zilles was elected last July (for three years) chair of the publications board of the Association for Computing Machinery. He is working for IBM's San Jose Research Lab, "investigating the use of intelligence in I/O and storage devices." He lives in Los Gatos with his wife, Connie, and two sons whom he does not name. (I mean he must have named them, but he didn't tell me the names.)

I had mentioned in the February/March column that **Robert O'Donnell** is with RCA in Moorestown, N.J. Further word is that he is in the Missile and Surface Radar facility, that he lives in Moorestown with his wife Janice, and son Brian, and that he is a senior member of IEEE.

And so ends the good news. **Joseph Goldberg,** who had been a computer analyst, died in San Fransico on January 27 at 41, apparently in an accident. Joseph left his wife, Judith Lesser, four daughters, and a son. I regret I have no address to which condolences might be sent.

Enjoy the spring flowers.—**Phil Marcus,** Secretary, 2617 Guilford Ave., Baltimore, MD 21218

64 20th Reunion

Greetings '64! Our TWENTIETH is upon us—just shortly after you read this. Thanks for all those donations to the Institute—the goodly number of alumni fund envelopes was the proof, and the necessary information for most of this column. Now to the envelopes.

Michael Auerbach has been quite busy traveling and lecturing. Last November he presented a talk on "Specialty Chemicals for Water and Energy" to executives of the Japanese Chemical Industry in Tokyo. Next, in December, he guest lectured in St. Croix at the West Indies Lab of Fairleigh Dickinson University. Then, in May, he attended the World Desalination Congress in Florence, Italy. Mike topped all these travels off by taking his three kids to a Red Sox/Blue Jays baseball double-header in Toronto. As for the job, he's still assistant director of Specialty Chemicals R&D at Pfizer.

Two former news releases have been written up and submitted (avec envelope, naturalement!). Dr. **Truman Brown** is now director of Medical Spectroscopy and NMR at Fox Cancer Center in Philadelphia and Dr. **Bruce Chrisman** is now in New Haven, Conn. as vice-president for administration at Yale University. More details on both of these announcements are in an earlier column.

William Euerle lives in Foxboro with his wife Anne and their two sons: Bill, 11, and Dan, 7. He's a program manager for several of the Foxboro Co.'s new products. . . . Now living in Beaverton, Ore. is **Michael Hale**, who is vice-president for Manager Systems Research and Development at Oregon Bank. . . . Good News—**Dave** and **Cindy Morrison** are the proud parents of a baby girl, Meaghan. She's offspring number two! Congratulations guys! Much happiness. . . . **C. Alfred Spencer** is software manager for Computer Controls Corp. in Wilmington, Mass.

Anthony Heatwole sends an update. He's now assistant vice-president at M/A-COM DCC, where he's been for eight years, working on the development of real-time microprocessor software for Packet Switching Networks and Satellite Communication. Two years ago he married Janet, and they now have a six-month-old son, Nathaniel. . . . **Jay Fenenbaum** is director of the Laboratory for Artificial Intelligence Research at Fairchild Camera and Instrument Corp. where he is responsible for research on "intelligent" systems and commercial exploitation of AI technology throughout Fairchild and its parent company, Schlumberger. Jay is also technical advisor to Technology Funding Inc., a San Francisco-based venture capital organization specializing in R&D partnerships in the computer and software fields.

Jon Gruber is still a partner at Montgomery Securities in San Francisco, a brokerage firm specializing in growth industries, in the technology and consumer industries. The firm has recently expanded to 275 people, necessitating a move to new offices at the TransAmerican Pyramid Building. Jon says the highlight of 1983 was winning the Robert F. Kennedy Tennis Tournament and enjoying the prize of going to the 49ers/Saints football game in New Orleans on the 49ers team plane.

One news release this month. . . . **Neil Orloff**, professor in the Cornell University College of Engineering and a nationally recognized authority on environmental law, has been named director of the Center for Environmental Research at Cornell. . . . **Carl Uhrmacher** advises us that class dues are $15 at a minimum and, naturally, we are all invited to contribute above that level to help the class defray expenses and spruce up our various reunions and other gatherings.

As for me, another season as soccer coach for my 11-year-old Lewis looms on the horizon, though the season, which has not yet begun (it's February), will be over by the time you read this (May/June). Experience (with George's bar mitzvah) tells me that we should already be planning Lewis' bar mitzvah (September 1985). When you read about that in this column, it (hopefully) will have been written by your next class secretary. I've really enjoyed the job, the news, and the trust, but, as I have often quoted **Ron Gilman**, TEN YEARS IS LONG ENOUGH!! CIAO!—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

65

Art Bushkin tells us that the company he started, Telemation Associates, is now two and a half years old, and that the scope of its activities has expanded considerably since its inception. The firm's initial focus was on providing analyses and assessments of resulatory and policy developments in such areas as communications policy, international trade, transborder data flow, high technology, and industrial policy. Over the years, the activity has been augmented to include product and market analyses to assist companies in enhancing their competitive market position, as well as a range of investment banking services including raising investment capital, evaluating investments, and structuring limited partnerships. Art's wife Kathy has been very busy as press secretary for Senator Gary Hart's presidential campaign.

Leo Rotenberg and Sue H. Winard were married in Philadelphia on December 7, 1983 (the seventh day of Chanukah). . . . Lilian and **David Carrier** write that they enjoyed a trip through western Canada last summer. They spent a week in Victoria and Vancouver, where Dave attended a conference, then went by bus across the Rockies to Edmonton for another week. Earlier in the year, Dave visited Perth, Australia (new home of the America's Cup), which is "about as far from Lakeland, Fla., as you can get." Dave says he guesses that passing through two antipodes on the globe, qualifies as circumnavigation. . . . **Dennis Bekeny** sends a note on two classmates' paths crossing. Dennis is in pediatrics and adolescent medicine. He has been named to the Advisory Committee on Children, Youth and Families by U.S. Congressman **Bruce Morrison** of the Third District in Connecticut.

My neighbor **Ed Hoffer** writes that he is in active private practice in Framingham, Mass., and that he also spends time at the Massachusetts General Hospital Computer Lab working on teaching programs and medical record systems. In his spare time, Ed serves as volunteer medical director of a hospice program and organizes an advanced training program for area E.M.T.s. Ed reports that Jed (13) and Scott (5) are now hockey players, and Pam is active in volunteer work for the Wellesley Scholarship Foundation and various youth activities. . . . Continuing with the Wellesley connection, **Gordon Stallings** writes, "for those who never heard," that he married Fran Osuss and they now have two fine children. Gordon is designing microprocessor systems for a living and enjoying it very much.

Several career notes this month: **Ed Bucher** has been promoted to assistant leader of the SATCOM Systems Engineering Group at M.I.T. Lincoln Laboratory. . . . **Jonathan Addelston** was appointed a vice-president in research and development operations at Wang Laboratories in Lowell, Mass., last May. . . . **Dennis Herrin** is an operations research and cost analyst with NAVAir, in Washington, D.C. . . . **George McQuilken** has moved from president to chairman and chief executive officer at Spartacus Computers. . . . **Jon Hanson** is still an account executive with Occidental Chemical Corp., but reports that he moved last year from Niagara Falls, N.Y., to Houston. Jon says that the Houston winters are much more pleasant than those in western New York.

Charles (Chico) Gholz writes that he is first vice-president and program chairman of the M.I.T. Club of Washington, D.C. He has taken the opportunity to get up a number of family-oriented programs to which members bring their teen-aged children to "see technology in action." Purely incidentally, Chico says that he has had a lot of fun taking his own teen-aged children to the programs. . . . **Bruce Golden** and **Sandy Morganstein** have helped organize the M.I.T. Enterprise Forum of Chicago. The Forum is similar to those in operation in Cambridge and Washington, D.C., in assisting high-tech start-up and maturing companies in reaching their financial goals. Other alumni active in the Chicago Forum include **Mark Arvin** and **Paul Fricke**. Sandy's company, Dytel Corp., made a successful presentation in December 1983. Bruce invites interested Chicago-area companies to contact him at McDermott, Will and Emery in Chicago.

Keep writing, and '65 will keep being represented in the *Review*.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

67

Sharlotte and I recently viewed the touring Vatican Collections in San Francisco as the guests of **Bill Murray** and Judy Bolin. Bill has made an outstanding contribution as the president of the M.I.T. Club of Northern California. Among his achievements is a one-third increase in club membership. During the tour we ran into Jan and **Dave Sanders,** whom we had not seem in several years even though they live nearby. (I am sure Dave will call me soon to set up a lunch or dinner—my treat. This is a good way to determine whether he reads these class notes.) . . . **Kenneth Sidman,** who was previously at Arthur D. Little, Inc., has been named director of new business development for Norton Co.'s Engineering Materials Group. He holds several U.S. patents and has received NASA's Award for Creative Development of Technology. . . . **Edward Geltman** is an assistant professor in the cardiology division at the Washington University School of Medicine. He is also medical director of the cardiac diagnostic laboratory at Barnes Hospital and an associate editor of the journal *Circulation*. He is continuing his research in nuclear cardiology and has been employing positron emission tomography in his studies for the last four years. Edward's wife Nancy is also with Barnes Hospital as a senior social worker in nuerology service.

George Nybakken writes that he is enjoying the four seasons in Middelbury, Conn., while working in corporate research and development as a senior research engineer with Uniroyal, Inc. During the last two years he has taken a product from the laboratory to full production. . . . **Pete Denton** reports a very busy year as president of Denton Vacuum, Inc. The improving economy is dramatically helping his vacuum equipment and optical coating products business, although he is having difficulty finding qualified engineers. He hopes to raise venture capital to take their one consumer product into national distribution. He and his wife Audrey and their children, Tracey (8) and Keith (6), enjoyed last summer in Newport, R.I., where they unfortunately saw *Australia II*'s first victory over *Liberty*. Pete has visited with **Joe Levanegie** and his family in Boston, and says they are all doing well.

Gloria and **Jim Small** proudly announce the arrival of identical twin boys, age 16 months, by adoption: "sort of instant parenthood squared with just two weeks advance notice." Jim is now physics division leader with Tetra Corp. in Albuquerque, N.M., where he is doing research and development in lasers, pulsed power systems, and high power microwaves. . . . **Gerald Tomanek** is doing another telecommunications startup, Cohesive Network. He recently had a chance to meet with **Roy Game** at MCI and **Bob Howard** of First Communications. . . . **John Robenson** is now sales development manager at Chelmsfund Division of Hewlett Packard. . . . **John Fittz** is a second-year student at the University of Connecticut School of Law. He is also project engineer in the instrumentation and controls engineering department at C-E Power Systems Group.

Nancy Hall is presently working for the New Jersey State Department of Health as an epidemiologist in occupational health. . . . **Andy Tanabe** continues as a programming manager at IBM. His wife Kathy is a part-time physical therapist, and his son, James Tokuichi (6), has been joined by a sister, Susan Kiyomi, born February 15, 1983.—**Jim Swanson,** 878 Hoffman Ter., Los Altos, CA 94022

70

James Lee Laing has moved from Chicago to Los Angeles and is assistant professor of ophthalmology at the University of Southern California. . . . **Michael Safonov** is also on the faculty at U.S.C. and is taking a sabbatical at Cambridge University in England. . . . **Robert Somers** is president of Advanced Software Associates in Southboro. He specializes in consulting in the area of diagnostic and testing of software. . . . **Ray Sekan** is president of Bike Security Systems, Inc., in Stoughton. He is the inventor and developer of the Citadel Bike Lot. Business has been expanding rapidly, and they now employ 45 persons. . . . **Robert Moore** is the staff scientist at S.R.I. International Artificial Intelligence Center and is also involved in Stanford University's Center for the Study of Language and Information. . . . Elaine and **John Friel** are living in Stamford, Conn., where he is a partner in Government Training Operations for Mabon Nuget and Co. They have purchased a plane and spend much of their spare time flying.

Leland Shaeffer, Jr., recently joined Apple Computer as a marketing manager. He and his spouse reside in Santa Clara. . . . **David Saar** recently changed jobs and is now vice-president of product development for Vector Automation, a manufacturer of CAD/CAM equipment. . . . **James Seaton** joined Axiom Technology in Newton. His

wife is involved in local government, and they live in Scituate. . . . **Dean Roller** is practicing cardiology in Coral Gables. He and his spouse have three children and are looking forward to their annual trip to Montana. . . . **Ronald Stoltz** has returned to the Sandia National Laboratories in Livermore after a two-year stint with Exxon Corporate Research Labs in New Jersey. He presently is a project scientist with the Engineering Components Group. He and his family live in the Bay area.

One of the fastest-growing privately held companies in the United States is Boston's Zoom Telephonics. **Frank Manning** is president of that company, which now employs 28 persons. Their product line includes automatic dialing equipment and other innovative telecommunication products. The automatic dialer was designed to make tennis court reservations at M.I.T.'s busy tennis court reservation number. . . . **Sue M. Winard** recently married Leo J. Rotenberg, '65, and now resides in Philadelphia. Both are medical doctors. . . . **Thomas A. Garrity** has been promoted to director of business development for Elanco Products Co., the agricultural marketing division of Eli Lilly and Co. He formerly was manager of animal products market research.—**Robert O. Vegeler,** Secretary, Dumas, Backs, Salin, & Vegeler, 2120 Ft. Wayne Natl. Bk. Bldg., Ft. Wayne, IN 46802

71

Sally Harvey Cortese writes, "Having given up engineering in 1977 for two years at the 'school up Mass. Ave.,' I became an M.B.A. in 1979. Employed at Digital Equipment Corp. since then I am now a financial manager and planning manager for the field service organization of D.E.C. in Stow, Mass., corporate headquarters. After M.I.T., I took up rowing, cross-country skiing, and running. Won national sculling titles in 1973, 1974, and 1975, but have retired due to work schedules. Enjoy gourmet cooking and living in 1892 Victorian house in Lincoln. Regards to all our classmates, especially civils!" . . . **Stan Kask** writes, "My wife and best friend Angie and I have been enjoying life in the nation's capital since the bicentennial. For the past five years I've been a senior personnel analyst at NASA headquarters developing agency-wide manpower planning forecasts. I recently began a master's degree program in computer science at Johns Hopkins University's School of Engineering. Last semester, I was quite surprised to run into **Jeff Trout,** who was updating his electrical engineering skills at Hopkins." . . . **Harrison Klein** writes, "After spending six years as chief engineer of the King Broadcasting radio stations at Seattle, and never expecting to leave such a perfect city, I succumbed to the lure of the major market! I'm now director of radio engineering for Westinghouse Broadcasting and Cable (Group W) in New York, where I'm in charge of technical operations of our ten radio stations and Muzak." . . . **Peter A. Stoll** writes, "I have moved from designing microprocessors at Intel to developing computer-aided engineering systems at Daisy Systems. Just a couple fewer miles to drive each morning. I need to start saving for my 4-year-old daughter's tuition—she has taught herself to read by listening to us read to her (well, just a little phonics on the side)." . . . **Louise Grochow** is now assistant professor of medical oncology at Johns Hopkins. Rebecca is 4 1/2 and Joshua is five months. They still live on Capitol Hill in Washington, D.C. . . . **Gary N. Pullar** is regional controller for Booz Allen and Hamilton, Inc., at Three First National Plaza in Chicago.

Stanley K. Gilbert, Jr., received his M.D. from the University of Virginia School of Medicine in 1975, completed his residency in orthopedic surgery at Brooke Army Medical Center in 1979, completed his army tour of duty in 1981, and is now in private practice in Fayetteville, N.C. . . . **Andrew H. Sims, Jr.,** is regional chairman for Southeast Connecticut/Southwest Rhode Island of the M.I.T. Educational Council. He is president-elect of Connecticut Waterworks Association and is a member of the state legislature task force on water supply. . . . **George Alvarez-Correa** is an investment officer with the pension plan of the World Bank. . . . **Mitchell Serota** is a fellow with the Society of Actuaries. He presented a paper at the Society's May meeting entitled, "Pension Funding in Light of the 1983 Social Security Amendments." Moderating the panel discussion was Pete Nutzel, '72. . . . **Richard F. Park** writes, "I am happy to report that I was married on August 30, 1983 to Laura Anderson Bennett (Smith College '72) a stockbroker with Ferris and Co. in Washington, D.C. We continue to live in Baltimore, as commuter train service to Washington has proven to be quite convenient. If any former residents of Runkle 2 are reading this, I'm sorry I missed the last reunion, but I hope there will be another." . . . **Daniel Weinberg** has published two books in the last couple of years: *The Economics of Housing Vouchers* (Academic Press) and *The Great Housing Experiment* (Sage Publications). His family is fine and his boys (ages 6, 4, and 2) are growing rapidly. . . . **Raymond B. Huey** is a VisiCalc product development manager—**Hal Moorman,** Box 1808, Brenham, TX 77833

72

Michael Rowny has left Bendix and is now vice-president and treasurer of M.C.I. . . . **Steve Tavan** moved to Mitre Corp. in August 1983, where he is working on the software side of a large electronic system for the Air Force. His children, Ethan (3) and Ilana (6), are growing fast (don't they all?). He is doing some photography and is active in his synagogue. . . . **Lawrence Marden** is an assistant vice-president at Morgan Guaranty in charge of client communications. He and Sheila are expecting a second child in June—son Andrew is almost 2.

Bob Reiter is working for IBM's Federal Systems Division in Gaithersburg, Md., as a software engineer. He just finished working on IBM's proposal to replace the F.A.A.'s air traffic control system. If our planes arrive on time, maybe we'll have Bob to thank! . . . Another IBMer, **Steven Chessin** has been at the Santa Teresa Laboratory in San Jose since July 1982, after finishing his Ph.D. in Physics at Berkeley. In typical M.I.T. fashion, he went back to work while still finishing school, and finished his dissertation just in time to meet the deadline for June 1983, graduation. In October, Steve and his girlfriend threw a big party: **Paul Magerl,** who is still in Palo Alto, was there, and so was **Paul Hirsohn,** who lives in Berkeley and works in Novato. Debbie and **Duane Lindner** did not make it, even though Duane is still at Sandia Labs. Steve says that **Bob Peterson** is at Boeing in Seattle, with his own consulting firm on the side; Bob keeps trying to recruit Steve, but Seattle is not appealing. Finally, Steve notes that **George Pavel** and **Lenny Pfister** are also in the area. . . . **Paul Mitchell** writes, "Still working, still dreaming."

Paul Hochfeld is supporting a small sheep farm by being an emergency room doctor in Corvallis, Ore. His 16-month-old son, Ben, is huge. Paul is trying to be "grandfathered" into being board certified in emergency medicine. . . . **Roger Mecca** has been named chairman of anesthesiology at Danbury (Conn.) Hospital. He moved from Wilford Hall U.S. Air Force Medical Center in San Antonio. . . . **Samuel Arthur** is leading a gospel rock and roll band named "Dayspring." They play mostly prisons and rest homes. . . . **Glenn Rowsam** has moved to the New York State Department of Social Services as an analyst for the Quality Assurance Bureau of Information Technology Management. . . . Since 1978, **Douglas Bailey** has been working for Corning Glass Works, currently as new product manager for consumer products. He keeps in regular contact with Jim Black, '69, in Atlanta, where he is a director of VideoStar Connections, a satellite networking company. Doug and Sara have a 3-year-old, Sara, who brightens their day.

Mark Mitchell finally finished his master's degree in operations research at the Naval Postgraduate School last April. He was sent to be assistant supply officer on the U.S. Enterprise (CVN-65). He and Konia are looking forward to living in the Bay area, but Mark reports that he expects to be at sea a lot, leaving Konia alone with their 3-year-old, Joe, and a possibly growing family. . . . **Richard Furman** is living in Miami and doing private consulting for various companies developing alternative coal-based fuels. Primarily he works with advanced coal cleaning and coal-water technologies for the conversion of power plants, industrial boilers, and gas turbines. . . . I have been doing lots of travelling recently with my job in corporate finance at Morgan Stanley and Co. I spend most of my time valuing companies for fairness opinions, tax litigation, and other purposes. I did take a pleasure trip down to the Super Bowl in Tampa, and I had fun even though it was too cold to lie in the sun and the game was not very exciting. Send your news.—**Wendy Elaine Erb,** 531 Main St., Apt. 714, New York, NY 10044

73

Lots of news this month. **Michael Cedars** is finishing a residency in plastic surgery at UCLA in July, after which he will do a craniofacial surgery fellowship. He and Phyllis expect child no. 1 this spring. . . . **Roger Bowers** now has three of the little ones. He is practicing radiology and nuclear medicine in Sayre, Pa. What small spare time he has is occupied with geneology, sci-fi, and his Apple II.

Dennis Tully got married this year to Dorene Reynolds, got his Ph.D. in anthropology and is doing research in Aleppo, Syria with the International Center for Applied Research on a Rockefeller postdoc. . . . **Richard Bratt** is now vice-president of software development for Spinnaker Software in Cambridge. . . . **Debra Judelson** and husband are proud parents of Dejah Renee ('05). . . . **Steve Waller** also had kids to brag on, Katie, 3, and Jean, 17 months. They will be moving to San Antonio in the summer.

Joe Hadzima has yet another daughter story, of Elizabeth in October. He is a corporate lawyer at Sullivan and Worcester in Boston and active in the M.I.T. Enterprise Forum, which his firm cosponsors. . . . **Forrest Milder** is an attorney as well, the tax kind, with Brown, Rudnick, Freed and Gesmer. Wife Sara and he moved to Needham last year. Their 2-year-old is named Stephen, and they, too have one on the way.

David Guttman received his M.D. from New York University in 1977 and now practices at Beth Israel in New York. His practice is in internal medicine and gastroenterology. . . . **Simeon Schwartz** practices internal medicine, hematology, and oncology in New Rochelle, N.Y., where he lives with wife Ellen and daughters Faye, 4, and Ariel, 2. . . . **David Moylan** is an assistant professor of radiation therapy at Jefferson Medical College in Philadelphia. His research includes treatment of lung cancer using radioactive monoclonal antibodies. . . . **Vitoon Vivatrat** has been an associate with Brian Watt in Houston, a small offshore structures consulting firm. He and wife Panarai and three little ones live in Kingswood. His work includes ice load prediction, risk-based design criteria, and reliability design. . . . Note your secretary's new address. We finally moved. —**Robert M.O. Sutton, Sr.,** "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74 10th Reunion

THE REUNION IS UPON YOU! Time is running out for those of you who have yet to return your RSVP forms. If you have not received your invitation and you are planning to attend, please call

either the Alumni Office at M.I.T., or any class officer (see two names below). To those of you who have volunteered to help out during the reunion: thank you! If any more class members would like to help out, please contact any member of the reunion committee for the Class of 1974. The volunteers have helped to keep the costs associated with the reunion activities at a minimum. Our class has the distinction of a very low cost per participant when compared with the budgets for other reunion classes.

Here now the news: Late last year, **Thomas M. Jahns** joined the General Electric Research and Development Center in Schenectady, N.Y. I would have passed on this information sooner, but I just received it from the *Review* office. Dr. Jahns: I hope that you and your wife will be able to make it to the reunion since you are now much closer to Cambridge than Rolling Meadows, Ill.

Baird Swanson writes, "Re: November/December '81 issue: I do NOT work on MVS. I work for the SPD division NOT DP. Moreover, most of my work is done using VM operating system. Please cease making things up for a laugh. It is not funny to me." Well . . . I don't really know what to say except that I hope to meet you at the reunion. Being a former IBM employee myself, perhaps we could trade old VM stories?

John B. Miller has finally checked in to say that he is currently an associate at Godsby and Hannah specializing in architect/engineer contracting and construction after graduating from Boston University School of Law in 1977. . . . **Leonard H. Sigal** is finishing his fellowship at Yale in rheumatology and will then take the position of assistant professor of medicine at Upstate Medical Center in Syracuse, N.Y. . . . **Andre Jaglom** has opened his own law firm in partnership with three others. The firm of Stecher, Jaglom, Nelsen, and Prutzman will ". . . do mostly litigation. . . ." Andre says that he will continue his practice of marketing and distribution law and helping clients' businesses get their products out to their customers. Congratulations and best wishes for continued success in your new venture.

Meanwhile . . . I have taken my consulting business one step further into the interactive videodisc training market in addition to the software and systems level consulting practice. I am also looking for people who would like to use their talents in this volatile and dynamic marketplace and work with some very wonderful people (myself included). The company is called Telematic Systems and is located at 55 Wheeler St. in Cambridge (Fresh Pond area).

This is my last column before the class business meeting during reunion weekend (this translates to Sunday brunch for many of you). Simply stated: my tenure as class co-secretary has been interesting. I will present more information at the business meeting. I am really looking forward to meeting all of you who will be attending. And finally, my heartfelt thanks to Lionel who is a pleasure to know and work with. Also, the other class officers (Sandy, David, and Marty) and the reunion committee members—**Linda Perry, Jay Krone,** and **Ron (Aron) Kuppersmith**—who have all done a wonderful job for the Class of 1974. Thank you.—**Jim Gokhale,** 12 Pond Lane, Arlington, MA 02174; **Lionel Goulet,** 21 Melville Ave., Dorchester, MA 02134

76

The mails have finally begun to firmly catch up with your traveling secretary. As a result, we fortunately have more news to report. . . . From Dr. **Mike Royal:** "Presently in the last year of an internal medicine residency at Walter Reed Hospital. Planning to go to law school next year to complete M.D./J.D." . . . And **Matt Breitenberg** "had the opportunity to testify as an expert witness in a bankruptcy case and two international trade cases (faintly reminiscent of tooling for finals!)." . . . Lori and **Steven Edelson** report laconically, "New daughter, Lisa Robin. New job. Proprietor of Edsun Laboratories, Wayland, Mass. New home, Wayland, Mass." Congrats on all of the news. . . . **Ethan Vacks** is "in my fourth year at the Boston law firm of Nutter, McClennen, and Fish, specializing in corporate law. My wife, Peggy (M.S.M., '78) has recently joined Applied Expert Systems, Inc (APEX) in Kenmore Square. Our two children, Nathaniel and Benjamin, are 3 and 1, respectively." . . . And a note from **Tom Hirasuna** and **Jean Hunter.** Tom "received an M.S. in chemical engineering from Columbia in May 1983, after several years of part-time study. Still at General Foods in Tarrytown, N.Y." Jean is "still a doctoral student at Columbia (chemical engineering)." . . . A news clip from the *Daily News* of Springfield, Mass., sends word that **George Dimitriou** has been promoted to full vice-president for financial planning at Bank of New England-West. George had gotten a master's from Wharton after the 'Tute, joined the bank in 1978, and became an assistant vice-president in 1979.

From **Alan Levin,** company news: "During the past year, I left CE/IDC to start a new company called Videotel. Funded by Citicorp Venture Capital and others, we have developed an in-room computer system which delivers a wide range of electronic services to hotel guests via a high-speed, proprietary two-way network using the hotel's master antenna system. Services include airline schedules, stock prices, video games, AP news wire, express checkout and others. After a highly successful hotel show in New York, we are now expanding operations throughout the U.S. Ask for us the next time you travel!"

Your secretary got a call from JFK airport and a subsequent postcard from **Mike Sarfatti.** He was on his way to a rush estimating job in Paris. The postcard, featuring a night shot of L'Arc de Triomphe, states, "Paris is marvellous. Spent a week in Paris, and I am now in Nice for three days. Heading to Monte Carlo today. Maybe I'll win?" Your secretary hasn't heard from Mike since, so I'm hoping he managed to retire in Monte Carlo. It really is a lovely place!

As for your secretary, by the time these notes are published, my wife Rita and I will have spent two weeks vacationing in Hawaii (Maui and Kauai) soaking up some needed sunshine and rest. In the interim, I am starting to examine some business deals revolving around trading futures, including possibly becoming what we call in my business, a "local" or floor trader. I am, of course, also trading for my own account and risk, mostly Swiss francs, British pounds, cocoa, sugar, heating oil, crude oil, gold, treasury bonds, and stock index futures. The trading does keep me busy, but in a different way than when I was directly part of Wall Street. One extremely pleasant aspect is that, most days, I am done at 3:15. I have also been doing some consulting on a commodity lawsuit to a Park Avenue firm and am finding it to be an interesting experience which may develop into a full-time business.

Please do write. We never have enough news to suit me.—**Arthur J. Carp,** Secretary, 211 W 79th St., Apt. 5, New York, NY 10024, (212) 362-2450

77

Our first note this month is a long letter from **Sarkis Koltookian.** Sarkis is designing tractor drivetrains for John Deere Co. in Waterloo, Iowa. Sarkis finds the area where he lives a bit dull, but gets away often. He vacationed for six weeks in the Northeast U.S. last year, and recently completed a Corvette tour of the West Coast. His West Coast tour allowed him to obtain an early tan and look up Phi Betta Sigma brothers Dave Wiederspahn, '78, and **Jake Krakauer,** Bill Kath, '78, and Mike Templeton, '78. Sarkis also advises the local Boy Scouts Engineering Explorer post. Finally, he writes "Pending completion of my ground-up '61 Corvette project, I may be ready for a move to either coast."

John P. Yangos set up a small OEM business designing and manufacturing hardware extensions and interfaces for Apple computers, primarily for the Greek market. Exports to some European countries are just beginning. . . . **Carolos H. Blohm** received his M.B.A. from Harvard in 1981 and is currently active in "family textile, electronics, and automative trade and industries." . . . **Matthew Sherman** is now back in Boston as a fellow in medical oncology at the Dana-Farber Cancer Institute.

Ken Stecklein recently moved to Florida. He is a project architect working on several large commercial development projects, but is also keeping his hand in residential design on the side. Ken saw **Jeff Singer** during the holidays. Jeff is still living and working in the Washington, D.C. area. . . . **Stephen Keith** is now working in Idaho Falls, Idaho, where the Navy trains sailors for the nuclear-powered fleet. Stephen is Navy advisor to Westinghouse, who runs the operation. Stephen enjoys being close to Yellowstone, Grand Teton, and lots of skiing, and invites classmates traveling in the area to stop by. . . . **Karen Kaufman** is working at General Dynamics Electronics Division as a senior engineer.

Glenn Brownstein was promoted in November from sports writer to assistant sports editor of the *Belleville News-Democrat* in Belleville, Ill., which recently became a morning newspaper. Glenn would like to hear from other M.I.T. alumni educated/working in journalism, and is curious to see how they are doing and where they are working. . . . As for myself, I'm getting ready to take my Gold Medal Dance test in roller-skating, and judging at local area competitions, when I'm not skiing. Mark, '76, and I would love to hear from classmates who are traveling here in Colorado.—**Barbara Wilson Crane,** Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

78

Well, folks, here we go with this month's gossip column. I've got lots of news (and loads of postcards) so let's dive right in. . . in no particular order. I just got a long letter from **Diane Prignoli,** who is living on Staten Island. Diane has left Columbia, and is now working in the serology labs of the New York City Department of Health. Her work runs from the mundane (titering antibody concentration in blood samples for "classical diseases"—like syphilis) to the exotic (AIDS research). As a hobby, Diane has "joined the ranks of deltiologists"—which I gather means collector of steamship trivia; she is the photographer for the Titantic Historical Society.

As I recently reported, **Karyn Altman** returned to M.I.T. to coach the women's volleyball team. Well, in her first year as a coach at the Tute, Karyn has been named NCAA Division III Women's Volleyball Coach-of-the-Year. Karyn's team went 41-2 and finished fourth at the National NCAA Division III tournament. (She also coaches men's volleyball at Wentworth Institute and serves as our class treasurer.)

Vinnie Paolino has entered the world of private dental practice. Vinnie opened shop in Haverhill, Mass., and on the side he is a staff researcher at the Forsyth Dental Center in Boston. I can tell you that the second salary will come in handy very soon, because Vinnie's wife, Paula (who works with me at the Mass. Rate Setting Commission), is expecting their first child any day now. . . . **George Orlov** writes to say that he is living in Cincinnati and working as a consultant to Cincinnati Gas and Electric, in preparation for the construction of a new nuclear power plant.

Curt Fennell reports that he has recently received a promotion to the rank of captain in the Marine Corps. Curt is serving with the 2nd Tank Battalion at Camp LeJeune, N.C. . . . Also on the way up, **Carol Pokodner** reports that she received her M.B.A. in December 1982 and is now work-

ing for the Bendix Field Engineering Corp. in Columbia, Md. . . . **Mark Samek** dropped a line to say that he is a senior engineer with Northeast Utilities in the Instrumentation Group—but he neglected to say where he was living. We'll be expecting to hear from you soon for a clarification, Mark.

Susan Coppersmith did about the meanest thing she could have done to a nosy class secretary. Her card contains three-and-one-half lines entirely crossed out and illegible. I'll be waiting to hear what that was all about. In the meantime, I can tell you that she has finished her Ph.D. and is now a postdoc at Brookhaven National Laboratory. . . . A bit more generous with his news is **A. David Stuart**, who is a group leader in Hughes Aircraft's Electro-Optical and Data Systems Group in El Segundo, Calif. David designs and develops automatic control systems for pointing space bound infrared sensors. Also, David has recently joined the M.I.T. visiting committee for the mechanical engineering department.

Mark Bye was recently appointed business development manager for the Air Products and performance Chemicals Division of . . . well, he doesn't say what company. Oh well, we *do* know that he's located in the company's corporate headquarters in Allentown, Pa. Mark and his wife (Marianne?) live in Morristown, N.J., which is the midpoint between Mark's Pa. commute and Marianne's commute to Wall Street (where she is a securities analyst).

Finally, there's me. In the past months, I have been reveling in the mass of boring postcards you all have sent me. Thank you thank you thank you, but in the immortal words of Tom Lehrer, "more, more, I'm still not satisfied." Here's a sampling, with the news they contain: **Teresa** and **Dan Nolet** sent me a picturesque view of the Greyhound Bus Terminal in Louisville, Ky. . . . **Rich Perlstein**'s contribution was an obscene photograph of a casaba melon. As Rich wrote, "it must be the most naturally explicit postcard in history. I never *dreamed* that casabas could be that juicy!" (Don't ask.) . . . **Tapio Kuusinen**'s, roughly translated, reads greetings from Finland. Tapio and his wife Eva (also Finish) were in Finland on business—as well as to spend Christmas with relatives.

Al Presser's postcards came from his recent trip to the Bahamas, and they include "Flamingoes on Parade," "Bahamas General Post Office," and "Legend of the Sea Stars." . . . **Paul "Malfo" Malchodi** sent me a postcard of four people dancing at the Berlin wall, while in Wolfsburg Germany on business. . . . A particularly appetizing card was "Navajo Taco" from **Dan Halbert**. (Dan is shooting for a June finish for his Ph.D. in computer science at Berkeley, while working for Xerox office systems division in Palo Alto.)

Jim Carr's addition to my collection is a change of address postcard. Jim and his fiance Susan are moving to Wisconsin, where Jim will do R&D work for Kimberly-Clark's Feminine Care Products Division "(no field test jokes please)." Jim asks me to ask, "Ralph Banse-Fay, where are you??" . . . **Pat Brown** and husband Tom Davidson sent me a not-so-boring postcard from no-so-boring Thailand, where Pat was working on an environmental impact statement for a fertilizer plant.

And last, and certainly not least, **Diane Prignoli** sent me a 1904 very boring postcard of the "Technology Building" in Boston. Thank you, thank you all. Keep those cards and letters coming folks.—**David S. Browne**, Secretary, 50 Follen St., No. 104, Cambridge, MA 02138, (617) 491-5313 (at work 727-1190)

79 5th Reunion

Hello classmates. I guess this is the last column before our 5th Reunion, so if you haven't written by now, you'll have to deliver your news in person. Incidentally, I hope to keep this job for another five years (crazy, no?)—and I hope you feel the same. See you at the 'Tute!

Got a nice note from **Scott Holmes,** who married Jean LaGue (Miami University, '78), got out of the Air Force last August, moved to Madison, Wis., bought a house, and started graduate school at the University of Wisconsin, Madison, in the department of nuclear engineering. Writes Scott, "I will be grinding towards a Ph.D. for the next four or so years. I'm working on superconducting magnets for fusion energy reactors—more or less a continuation of the work on cryogenics and superconductivity that I first became involved with at M.I.T. The 40,000 students here took some getting used to and I've noticed the professors have to spend more of their time teaching intro level courses (bringing the students up to speed in algebra, computers, etc.) with consequently less time to spend on higher level courses. But then, I couldn't afford a house in the Boston area!"

Douglas Morrow just started a new job with Lever Brothers in New York City, working with Manufacturing Planning and Control Systems and progressing toward APICS certification. . . . **Paul Thompson** is investing in oil and gas exploration with NWT Natural Resources Co. in Chicago. . . . **Joe Egan** is at Columbia University Law School here in New York . . . **Bruce Gage** has just graduated from medical school and is spending a year doing research. Next year, he'll begin a psychiatry residency at Harvard while his wife does a post doc at M.I.T. . . . **Gregory Bosch** has returned to graduate school at Cornell after four years in industry. On October 20, 1983, he became the proud father of daughter Katherine Ann. Congrats!

Jim Lester writes, "Looking forward to the reunion—our baby should be 4 months old June 10, so we'll bring him/her back to see the sights of Boston. At work, I have been concentrating on the law of government procurement of ADP equipment and software. I went to a seminar on ADP procurement in Florida at Halloween and saw Linda and **Charlie Evans,** who are comfortably settled in Tampa where Charlie is a soils engineer for Greiner." . . . **Robert Briselli** is working for DuPont in southern Michigan, developing topcoat paint and supporting the paint activities at Honda's new auto plant in Ohio. He wants to know, "What are the M.I.T. Symphony people doing these days?" . . . **David Millar** is living in Moorestown, N.J., and working in Camden, N.J., at Campbell Soup Co. as a systems project manager. . . . **Charles Crespi** started a new venture called Gentest Limited Partnership with Bruce W. Penman, '72, and George H. Wayne,'48. He writes, "We are offering human cell tests for safety of new drugs and chemicals to industry and the government." Good luck, Charles!

Some exciting news regarding your faithful secretary. On October 21 of this year, I will be getting married to Robert Lustig, '76. Some of you may remember that Robert and I dated back at M.I.T., but things didn't work out. Well, after nearly eight years, we've recently realized that while it may be better to have loved and lost than never to have loved at all, the best alternative by far is to have loved and won! We met originally via an M.I.T. Musical Theatre Guild production of "Fiddler on the Roof," in which I played Tzeitel and he played Fyedka. Robert is now a pediatric endocrinologist doing a fellowship at the University of California at San Francisco, but he'll be moving back to New York this summer. As I told him, one benefit of marrying me is that he'll never have to write to his own class secretary again! Wishing you all happy news.—goodbye 'til reunion time.—**Sharon Lowenheim,** Secretary, 131 E. 83 St., Apt. 2G, New York, N.Y. 10028

80

I am sorry to report the death of classmate **Nikki Veltfort** in November 1983. . . . **Seanna Watson** reports that she is living just outside Ottawa, Ont., and working for Northern Telecom Electronics. . . . **Todd Serota** received a juris doctor degree from Dickinson College of Law last June. . . . **Michael Mullins,** received his Ph.D. in chemical engineering from the University of Rochester last May. . . . **Josephine Adams** is a project manager for James L. Robinson P.L. Architects and Planners, and recently got married. . . . From **Susan Wildin**: "I'm a fourth-year medical student at Baylor College of Medicine in Houston, planning to specialize in pediatrics." . . . **Errol Antzis** writes, "I graduated from New York University Graduate School of Business in June 1982, and am now employed by Chase Manhattan Bank in New York, N.Y., as a technical director.." . . . **John Edkins** is the Canadian Navy exchange officer at David Taylor Naval Ship Research and Development Center, Md., working in the advanced concepts office of the systems development department. . . . **James Garmirian** is a research engineer at the Badger Laboratories, studying synthetic fuels production.

From **David Gravens**: "In August, I accepted a position as telecommunications analyst with NBC and moved to Dobbs Ferry in Westchester County, N.Y. I am now working as a member of a team designing and implementing NBC's new data communications network using six Tandem Non-Stop II computer systems. I am also learning to use my Atari P.C., and hope to write and market personal software." . . . **Namir Kassim** reports that he is in the astronomy Ph.D. program at the University of Maryland, College Park, and is currently involved with very long wavelength radio astronomy at the school's observatory east of San Diego. Current project: density structure of the outer solar corona. . . . **Bruce McIntyre** writes, "I'm now living in Japan and working for Nippon Megatest K.K. I've been working with bubble memory testing here, and enjoying a period of cultural exchange."

Mark Mooradin recently moved to a new apartment in Hermosa Beach, Calif., and is playing ice hockey every week in a local league. . . . **Geoff Cooper** reports that he received his S.M. in electrical engineering and computer science in May 1983, and moved to Palo Alto to work as a manager of network systems for IMAGEN Corp., a manufacturer of image processors to run laser printing engines. . . . **Max Blosser** is working in the Structural Concepts Branch at NASA, Langley Research Center. . . . **Tim Easterly** writes, "I'm presently working in TOW Project Office, Redstone Arsenal, Ala. TOW is an antitank weapon system. I spend six months travelling, often deploying a thermal night sight for the system. This gave me a chance to see many classmates from M.I.T."

Brian Clouse reports, "I'm back in Boston, designing jet engine parts for G.E. in Lynn. While living in New Jersey, I met and married Martha Dietrich of Trenton. We unfortunately had scheduled the service for the morning after the worst blizzard in 30 years, and we had to make a lot of last-minute changes, but pulled it off, getting to our Hawaii honeymoon only a day late." . . . From **Barbara Johnston:** "After two and a half years in the D.C area, I have recently moved to Charlotte, N.C. I donned my hard hat and steel-toed boots and accepted a position as project engineer with McDevitt and Street Co., a general contractor. I have learned that the Civil War is actually the War of the Northern Aggression." . . . From **Daniel Sable,** "I am still at RCA Astro-Electronics in Princeton, N.J., but also an adjunct professor of E.E.T. at a local community college."

Ed Gillett writes, "I am presently in my third year at New Jersey Medical School in Newark. A couple of weeks ago, I got together with **Jim Zaorski, Russ Blount** and **Bob Humphries,** and four women for some beers and dinner in Philadelphia, where Russ has just bought a house. We had a good time, with talk centering on the present rather than our past at M.I.T. Jim just finished Rutgers Law School and is moving to California to seek his fortune. Humps is still with the Navy, attending George Washington Law School and living in Alexandria, Va. I won the

senior heavyweight eight event at the U.S. Nationals this past summer, but Russ elected to train through the nationals, made the Pan American games, and captured a silver in the four without for the U.S. team. He has some interesting observations about his work-related travels to Saudi Arabia and his rowing related travels to Venezuela. **John Stenard** was just transferred to Brooklyn Navy Yard. He couldn't make the dinner in Philadelphia because of some car trouble, but I saw him this past weekend and we quaffed a few brews together. I am trying to talk him into rowing for the N.Y.A.C."

Keep in touch. Looking forward to hearing more for the next column.—**Debra A. Utko,** 13A Soldiers Field Park, Boston, MA 02163

81

Having missed everyone in '81 since our graduation, I thought I'd give Chuck a hand (and a vacation) by herein presenting the latest in '81 affairs. I am truly impressed with how interesting and varied our class has become. Incidentally, Chuck wants to encourage any '81er to volunteer to write this column. It's a great idea, and no application is rejected.

As for me, **Mitchell Brook,** I am presently in the second year of law school at the University of Pennsylvania. Aside from studying the law, I keep busy editing an international law journal, enjoying the vast cultural offerings of Philadelphia and, for course, consuming large quantities of such traditional local delicacies as cheesesteak hogies and soft pretzels. This summer, I am looking forward to working with a patent law firm in Century City, Los Angeles. An '81 Olympics get-together is being planned for around the beginning of August, so if you will be in L.A. for the Olympics (or any reason) write or call me at the address or number below and I'll send the details. Also here at Penn are the following Wharton School of Business students: **Bob Davies,** who as you read this will be walking down the Champs Elysee in Paris; **Jim Sugerman,** who likes Penn but, like others, feels "stuck in Philadelphia;" and **Chun-Chee Lau,** who will be a wiz in the International Finance Department of Johnson and Johnson Corp. this summer. Chun-Chee will graduate in December.

Jonathan Koch called last night from Salt Lake City, Utah, where he writes CAD/CAM software at Evans and Sutherland Computer Co. He reports that although the nightlife is limited, the skiing is the best in the world, especially Alta. Being the congenial person we all know him to be, Jonathan invites all '81ers to call or drop by for a drink at any time, even 1:00 a.m., like when he called me. . . . **Anita Bliss** is still living in tune with Silicon Valley. She has foresaken Stanford and Harvard business schools (perhaps temporarily) so that she can continue having fun making discoveries on the frontiers of technology at Shugart Corp. Her car "Fido" is dying, so she is looking forward to getting a new one soon. Anita recently bumped into another Valley-person **I-Wen Wung** who is with Cignetics Corp.

Among other classmates who were defending the Republic is **Duane Nakahata,** who is presently stationed aboard a fast attack submarine, the *U.S.S. Tautog,* in Pearl Harbor. Recently he became a "Bluenose" after he and his vessel completed a mission to the North Pole. . . . **David Hills** is a first Lieutenant in the USAF at Wright-Patterson AFB, and is pursuing a master's degree at University of Dayton on a part-time basis. He recently married Adrianne Phillips, an alumna of the Longy School of Music in Cambridge, Mass. . . . **Pat Bigot** is a sonar officer aboard the *U.S.S. Flasher* and should be stationed in San Francisco for a few years.

Representing the computer boom contingent this month are **Bruce Blumberg,** who is manager of Development Tools and Third Party Products in the Lisa Division of Apple Computers, and **Hisao Miwa,** who is vice-president of engineering at Computer Services International Corp. (CSI) in Englewood Cliffs, N.J. CSI is a subsidiary of the largest systems firm in Japan.

I am please to report that our classmates, **Denise Dzwonczyk** and **Andre Cohen,** have recently wed. After honeymooning in Bermuda, they returned to California where Denise works at the Jet Propulsion Laboratory in Pasadena, and Andy works at TRW in Redondo Beach. . . . Also in the sunny Los Angeles area is **Daniel Packer** who has married Bonnie Feinroth. Daniel has a job we all envy—analyst in the ticketing department of the Los Angeles Olympics Organizing Committee. He hopes everyone enjoys the Olympics. . . . **William Topazio** writes that he got married last May. His wife Maria enjoys playing the guitar and funky banjo, and he works at Editel/Columbia Pictures. He says hello to all the Strobe Lab and film/video folks.

Hallie and **Daniel Kon** have been living happily in Jerusalem, Israel. Daniel is working with a large aerospace company. By the time this column is printed, they should have defeated the world renowned Israel housing crunch because their house in Karnei Shemron will be completed. . . . **Gabriel Warshaw** is enjoying cross-country skiing on the high-quality snow that falls in Ottawa, Ontario. He visited the 'Tute while he was in Boston for the ASME winter meeting. He reports that M.I.T. doesn't appear to have changed much except for a few new buildings and lots more computers. Gabriel is working at Canadian Astronautics Ltd. as a mechanical systems engineer in the Space Division.

I have enjoyed writing this for everyone and sincerely wish all my fellow '81 classmates the best of luck, good fortune and good health.—**Mitchell Brook,** Acting Secretary, 2220 Walnut St., No. 812, Philadelphia, PA 19104, (215) 496-0391; **Chuck Markam,** Secretary, Box 54, M.I.T. Branch, Cambridge, MA 02139

82

Hello, classmates! Most of the news this month comes from contributing editor and fellow classmate **Steve Taylor** (he's been promoted from assistant secretary). Steve says that not much (actually nothing) has happened in his life but he has heard news. **Doug Finch** finished his master's at M.I.T. in aero/astro and has moved to California to work for Aerospace. . . . **George Kroznak** is threatening to graduate in June along with **Paul Conway.** Paul will be receiving his M.S. and B.S. in Course VI-A. (Usually I remind people what the course numbers stand, for, but if you can't remember what course VI is, you're in big trouble!)

I forgot to mention that last month's postcard-of-the-month award went to **Rita Nothaft, Barry Mirrer,** and **Lynn Schnapp** for their beauty of Equador. . . . **Michael Post** has been practicing his coloring on me. (Actually, not on *me* but on his letter to me.) He sent me a lovely note complete with green hills and mountains. Michael says, "Yes, I've survived the harrowing ordeal of nuclear prototype training in Idaho." (I wonder if it was the ordeal of training or Idaho that he survived. Sorry, Idaho fans, I'll try to keep my opinions to myself!) (Sure you will, Rhonda. Be serious!) Anyway, back to Mike's letter. Right now Mike's at Surface Warfare Officer's School in Newport, R.I., and any day now he'll be heading down to luxurious Norfolk, Va. From there, he'll be shipping out for parts unknown. . . . **Ginny Gozzo** is working at Griffis Air Force Base in Rome, N.Y., in a civilian job as an electronics engineer. . . . Hope to hear from all of you soon!—**Steve Taylor,** Contributing Editor, 207 Bartonwood, Ct., Niceville, FL 32578; **Rhonda Peck,** Secretary, 38 Bigelow St., Cambridge, MA 02139

83

All of you will be happy to know that my column has become extremely popular, which makes me tremendously happy! I received notes from nearly 20 people since my last column. **Eric Johnson** asked if I would write to clear his name. In the last issue Eric was quite abusive to M.I.T. coeds. To set the record straight, Eric says that there was no malice intended towards our coeds, he just never enjoyed any dates he had. Fortunately, Mr. Johnson's luck is not much better in Maine. . . . **David Brackman** writes that he is assistant director for the Shakespeare Ensemble's production of *The Temptest.* . . . **Bud Hobart** writes that he is getting bored working for Xeni, a new start-up firm in Ohio. Apparently, designing new tire treads is not all people make it out to be. He also says that he and Wilma tied the knot? Among other things, he sends his love and good wishes to Course IIs at Student House.

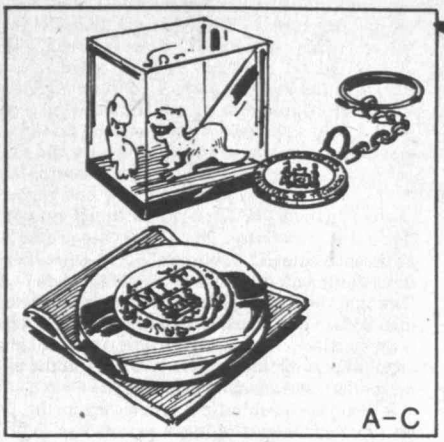
Matthew L. Russel says that he has just successfully launched a new company, Control Key Corp. His motivation does not stop there. He is looking to set up another company in the area of robotics for next spring. If anyone has any good ideas, write to Matthew. Congratulations and good luck on your new venture. . . . **Victor Gilberti** is currently working for Burns and Roe, Inc. in Oradell, N.J. on advanced breeder reactor concepts. I guess everyone figures out that Victor was Course XXII. But he does have interests outside of U_{238}. He spent last summer helping to renovate a brownstone in Hoboken, N.J. . . . As a sponsored research member, **James F. Kirk** is working on the development and testing of artificial skin in the M.I.T. Fibers and Polymers Lab.

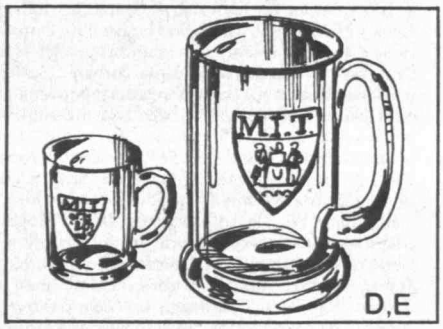
Matthew Haggerty and **Kenneth Segel** both sent in token messages. Matthew decided to leave crew and go to grad school for mechanical engineering at Yale. Ken is currently conducting a write-in campaign for president of the U.S. using a similar Gumby campaign. He said the New Hampshire primaries were slow but he hopes to do well in Ohio. Congratulations Matthew, and good luck Ken! . . . **Mark Childs** just returned from a trip through the wilds of Alaska and is currently hanging out in Colorado until he leaves for Fort Gordon, Ga. to serve as second lieutenant in the army. Mark writes that **Patrick Bacaj** is currently in the University of Virginia medical school and, due to his financial situation, is considering opening a mortuary with his brother Faton. . . . **Gardell Gefkey** took a little bit of time off, touring England and then coming home to cook hamburgers for the boys back in the States at Wimpies. . . . **Joe Drake** is combining triathlons with his master's thesis. It will be a race to see which one he finishes first. . . . **Charlie Lamb** might be engaged, according to Mark. Mark says that he is not sure if the bride to be is Charlie's computer or his bicycle. . . . **Ramon Solorzano** intends to graduate this spring. . . . **Howard Kolodny** still works with computers and poetry in Boston. . . . **Jeff Myers** is established in both Hewlett Packard and Colorado's state swimming records book. Thanks for all of the news, Mark.

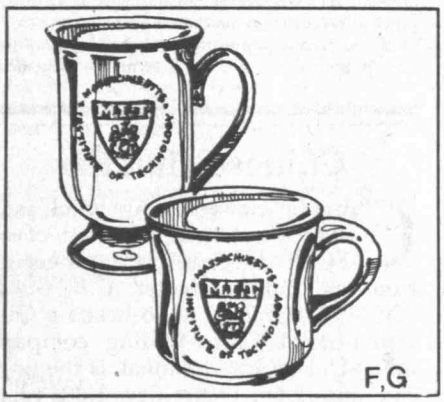
Our celebrity '83 for this issue, **Richard (Mark) Fenton,** is currently living at the U.S. Olympic Training Center in Colorado Springs, Colo. He is training for the 50-kilometer race walk. He also has a research assistantship in the biomechanics laboratory there. His duties include computer programming and hardware interface work as well as biomechanical research with track and field athletics, ski jumpers, archers, fencers, and bobsled and luge competitors. Sounds like you are having a great time, Mark. Good luck in the trials. We will look for you in Los Angeles.

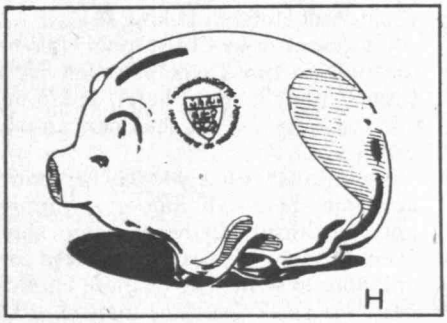
As for myself, hopefully, by the time this article is written my thesis will be finished. I plan to spend the summer bumming around Europe. Currently I am still interviewing for jobs. But due to the lag on these articles, you won't find out what I am doing until September. That is assuming I don't run into any of you in Europe, in which case I'll be glad to tell. Keep the letters coming.—**John E. De Rubeis,** Secretary, 86 Mt. Vernon St., Boston, MA 02108

M.I.T. Insignia









A. **CLEAR ACRYLIC PAPERWEIGHT.** Pewter M.I.T. beaver mascot mounted inside. **$15**

B. **SOLID BRASS PAPERWEIGHT** with M.I.T. seal engraved. **$15**

C. **INSIGNIA KEYCHAIN** of brushed pewter. **$6**

D. **SHOT GLASS** with M.I.T. insignia seal. **$3.50**

E. **GLASS BEER MUG** with platinum M.I.T. insignia seal. **$6**

F. **M.I.T. CERAMIC IRISH COFFEE MUG.** Gold trim, handle and M.I.T. seal. **$15.50**

G. **M.I.T. COFFEE CUP.** Ceramic with tri-color insignia seal. **$5.95**

H. **CERAMIC PIGGY BANK.** Creamy white, gold trim ears and hooves. Scarlet. M.I.T. seal. **$12.95**

J. **BRUSHED ALUMINUM MUG** with pewter insignia seal and clear glass bottom **$17**

M.I.T. ACTIVEWEAR BY CHAMPION

K. **M.I.T. CREWNECK STYLE SWEATSHIRT.** Cotton / acrylic fleece in scarlet / white seal or grey / scarlet seal. Adult sizes S, M, L, XL. **$16** (Not Shown) Hooded Sweatshirt with pouch pocket, sizes S, M, L, XL. **$20**

L. **M.I.T. T-SHIRT** with contrasting banding and insignia seal in grey or maroon, adult sizes S, M, L, XL. **$8.** Youth sizes XS, X, M, L. **$7.**

M. **M.I.T. BEAVER T-SHIRT** in white with scarlet trim. Cotton / polyester blend, adult sizes A, M, L, XL. **$8** Youth sizes XS, S, M, L. **$7.**

HARVARD COOPERATIVE SOCIETY **the Coop**

All items available at M.I.T. Student Center. Tech Coop open Mon.-Sat. 9:15 to 5:30. Coop Charge, Mastercard, Visa and American Express welcome. Call toll free: 1-800-792-5170 within Mass., 1-800-343-5570 outside Mass.

Courses

I

Civil Engineering

Michael D. Meyer, Ph.D.'78, associate professor in the department at M.I.T., is in the midst of a major traffic problem: how to reroute Boston commuters while the Southeast Expressway is rebuilt during the next two years. He's on leave to be director of the Bureau of Transportation Planning and Development for the Massachusetts Department of Public Works.

Assistant Professor **Clifford Winston,** in the department at M.I.T., was co-recipient of a $1,000 award for the best paper on the intercity bus industry at the Transportation Research Forum early in February. The award, shared with Professor Steven A. Morrison of Northeastern, was sponsored by the American Bus Association. . . . **John M. Jentz,** S.M.'56, is the founder and chairman of a new company, Kauai Mountain Tours. It is the first tour company licensed to conduct tours into the beautiful mountainous interior of the island of Kauai, Hawaii. . . . **Gershon Kulin,** Sc.D.'55, received a Bronze Medal Award from the National Bureau of Standards, Gaithersburg, Md., for his contributions in the mechanics and measurement of open channel flows and work in solid-liquid flows. . . . **David C. Curtis,** Ph.D.'82, is president of the newly formed International Hydrological Services, Bloomfield, Conn., a consulting, engineering, and development company specializing in computerized "instant" or real-time environmental data.

Gerhard H. Jirka, Ph.D.'73, on the faculty at Cornell University, has won the Walter L. Hurber Prize of the American Society of Civil Engineers (ASCE), cited for "his work in the field of environmental fluid mechanics, specifically pollutant transport phenomena in water quality, stratified flow, turbulence, fluid mechanics and related studies." . . . **Max D. Sorota,** S.M.'50, president of Fay, Spofford and Thorndike, Lexington, Mass.; **Edward B. Kinner,** Sc.D.'70, principal and senior vice-president of Haley and Aldrich, Inc., Cambridge; and **Mark X. Haley,** S.M.'75, a senior engineer at Haley and Aldrich—have won the Thomas A. Middlebrooks Award of the ASCE. The three were cited for their paper "Cellular Cofferdam for Trident Drydock Performance," which appeared in the December 1981 issue of the ASCE's *Journal of the Geotechnical Engineering Division*. . . . **Neil S. Shifrin,** Ph.D.'80, writes, "I recently became a principal in Cambridge Analytical Associates. Technical work has recently focused on hazardous waste landfill remedial projects, such as Love Canal and S-Area in Niagara Falls, N.Y."

Donald H. Evans, S.M.'73, who had been employed as a civil engineer with Bechtel Power since leaving M.I.T., passed away in his home in Ann Arbor, Mich., on January 20, 1983. . . . **Philip C. Stein,** Sc.D.'40, senior partner in the Stein Seal Co., Philadelphia, Pa., passed away on December 1, 1982.

II

Mechanical Engineering

"Will the Winds of Windsor Generate Energy?" asks the *Boston Globe* headline. The answer lies partially in the hands of **Thomas L. Dinwoodie,** S.M.'80. As president of TDEnergy, he wants to build a wind energy farm—60 to 75 windmills—atop a hill in Windsor, Vt., at an estimated cost of $6.5 million, and he says construction could begin as early as June.

Professor **David Gordon Wilson,** in the department at M.I.T., has become president of the International Human-Powered Vehicle Association for 1984. Wilson, a leading contributor on the mechanics of human powered vehicles, is co-designer of the Avatar 2000 recumbent bicycle and co-author of *Bicycling Science*. . . . **Karl N. Reid, Jr.,** Sc.D.'64, professor and head of the School of Mechanical and Aerospace Engineering at Oklahoma State University, Stillwater, has been named a fellow of the American Society of Mechanical Engineers (ASME). Reid has taught systems science, automatic controls, fluid power and fluidics, and he is recognized for research in systems science, the use of computers in engineering education, and biomedical applications of fluid elements. . . . Also named an ASME fellow was **Philip A. Thompson,** Sc.D.'61, professor of mechanical engineering at Rensselaer Polytechnic Institute, Troy, N.Y. Thompson has made contributions to the understanding of fluid dynamics, especially in the areas of energy storage and retrieval. . . . **Uri Tsach,** S.M.'78, has been associated with Stone and Webster Engineering Corp. (since 1982), where he has been involved in the development of a computerized failure detection model—based system for a fossil power plant.

Erwin G. Loewen, Sc.D.'52, director of the Gratings and Metrology Division at Bausch and Lomb, has won the 1984 David Richardson Medal of the Optical Society of America. Loewen is cited for his "contributions to the science, technology, and applications of both conventional and holographic diffraction gratings and for documentation of progress of this field in the scientific and engineering literature." . . . **Daniel R. Lynch,** S.M.'72, assistant professor at Dartmouth College's Thayer School of Engineering, has received a President's Young Investigator Award. His research, which will be aided by the new grant may bring as much as $1 million in research funds to Dartmouth during the next five years, focuses on the development of computer methods for a broad spectrum of science and engineering problems.

III

Materials Science and Engineering

The memory of the late **John Chipman,** who was head of the department at M.I.T. from 1946 to 1962, is to be honored by the creation of a "junior professorship" in his name, and a $600,000 fund is now being sought. Professor Chipman is described by Professor **Merton C. Flemings,** '51, who now heads the department, as one of its "great builders" who "brought the department to its position of pre-eminence during 16 years as department head." Chipman is also cited for "pioneering work on metallurgical thermochemistry" that "laid the basis for modern steelmaking technology."

A two-year postdoctoral fellowship in the prehistoric metallurgies of the Americas has come to M.I.T.'s Center for Materials Research in Archeology and Ethnology, and it will be used by Dorothy Hosler, a doctoral candidate in anthropology at the University of California at Santa Barbara. Hosler's work will document cultural relations between ancient peoples of western Mexico and the Andes—important because such relations, if any, must have occurred by sea. Donors of the funds are the American Smelting and Refining Co., Inc., and its subsidiaries in Mexico and Peru.

Professor **W. David Kingery,** '48, is program chairman for a special forum on the history and prehistory of ceramic art, science, and technology during the 86th annual meeting of the American Ceramic Society in Pittsburgh on May 1. Kingery himself will speak on the development of European porcelain technology, and he is co-author (with Pamela Vandiver, lecturer in the department) of a report on Song Dynasty ceramic technology. Suzanne

Chinese Hotelier

China's "newest luxury hotel" isn't exactly what is expected of an M.I.T. mechanical engineering alumnus. But no matter: C.B. Sung, S.M.'48 Mech.Eng., who heads a California-based China-trading company called Unison International, is the principal developer of the new 1,000-room Great Wall Hotel in Peking.

It's described by Christopher H. Wren for the *New York Times* News Service as China's most modern hotel, at $75 million the biggest Chinese-American joint venture yet.

Americans are likely to feel very much at home there—an indoor swimming pool, nightclub, 24-hour coffee shop, even "China's first computerized reservations system. The Chinese employees wear sleek uniforms instead of the usual solid white jackets," writes Wren, and "their training program stresses knife-and-fork etiquette and the pronunciation of English tongue-twisters like cauliflower."

P. de Atley, assistant professor of anthropology and archeology, spoke on the development of glaze paints in the prehistoric American southwest.

Professor **Nicholas J. Grant,** Sc.D.'44, in the department at M.I.T. has become a director of Phone-Poulenc, Inc., a subsidiary of Phone-Poulenc S.A., Paris, France. . . . **William R. Prindle,** Sc.D.'55, director of administration and technical services for the Corning Glass Works Research and Development Division, Corning, N.Y., was presented the 1983 Phoenix Award. Prindle was selected as the glass industry "Man of the Year" by the Phoenix Award Committee, a group of glass industry suppliers; he was cited for his commitment to the industry and his many accomplishments which have made him an authority on the management of materials research and development as well as on the structure and properties of materials.

Frances Hund Clark, Sc.D.'26, the first woman to receive a doctorate in metallurgy at M.I.T., passed away on December 19, 1983. Clark was also the first woman to receive an S.M. degree in chemistry (1922) from M.I.T. She taught in the Chemistry Department from 1921 to 1926, and in 1926 she joined Western Union as an expert on non-ferrous metallurgy and copper alloys—to found the company's metallurgical laboratory.

IV

Architecture

Martin Bressani, a graduate student in the history, theory, and criticism section of the department at M.I.T., has won the department's first Marvin E. Goody Prize in the Building Arts—a $5,000 award—for his proposal for a Master's thesis on the relationship of new building materials to building form. Bressani's example will be French architect Auguste Perret's building at 25 rue Franklin, Paris—the first use of reinforced concrete in a building. Bressani's question: how and why did Perret incorporate this then-relatively-new technology into his architectural thinking?

Richard Leacock, professor of cinema in the department at M.I.T., premiered his new film in Paris at the Autumn Festival of the Arts. The film—a documentary, *Lulu in Berlin*—is an interview between Leacock and the legendary screen actress Louise Brook, integrated with many of her film clips. . . . **Robert L. Ziegelman,** M.Arch.'59, and his firm (Carl Luckenbach/Robert L. Ziegelman, Inc., Birmingham, Mich.) have been given a design award by the Michigan Society of Architects. The award was for the design of the Handelman Warehouse, Addison, Ill., and the Medallion Building, Farmington, Mich.

V

Chemistry

Mark Wrighton, Frederick G. Keyes Professor of Chemistry at M.I.T., was the recipient of the $1,000 Gregory and Freda Halpern Award in Photochemistry sponsored by the Polychrome Corp. at the New York Academy of Sciences annual meeting last December. Wrighton was cited for his research and teaching in the field of photo-chemistry. . . . **John S. Waugh,** Arthur Amos Noyes Professor of Chemistry at M.I.T., has been named a co-recipient of the Wolf Foundation Prize in Chemistry for 1984. Waugh was cited for "his extension of high resolution nuclear magnetic resonance to solids and to substances in very low concentrations." Professor Waugh receives the $100,000 prize from Chaim Herzog, president of Israel, during a special meeting of the Israli Knesset in May.

Jerry K. Larson, Ph.D.'67, manager of employment for the Pfizer Corp., Groton, Conn., was guest speaker at the Killingly-Brooklyn Chamber of Commerce annual dinner in Danielson, Conn., last February. For 12 years before taking his present post Larson was manager of Pfizer's clinical science services. . . . **Joel A. Silver,** Ph.D.'76, has been promoted to principal research scientist in the Division of Applied Sciences at Aerodyne Research, Inc., Billerica, Mass. Silver's research includes the chemical kinetics and spectroscopy of advanced combustion systems and the atmosphere. A member of Aerodyne's scientific staff since 1978, he also serves as associate director of the company's Center for Chemical and Environmental Physics.

VI

Electrical Engineering and Computer Science

Ellen Hildreth, '77, who's a member of the M.I.T. Artificial Intelligence Laboratory, is now associate director of a new Center for Biological Information Processing in the Whitaker College of Health Sciences, Technology and Management at M.I.T. The center's goal is to study the human systems that underlie the control of vision and movement—a topic clearly related to Hildreth's work.

Congratulations to **Deborah L. Rennie,** '85: she's won the first Omnet, Inc., Sara J. Manley Scholarship at M.I.T. Omnet, Inc., describes itself as "the country's only electronic mail management company," and the scholarship honors a valued employee who died unexpectedly late last year at the age of 27. The company's principals, including **Robert Heinmiller,** '62, have asked that the scholarship awards be limited to undergraduate women who plan careers in telecommunications technology or policy—"gusty, intelligent women who believe in the future of telecommunications."

Richard G. Bratt, '73, has been promoted to vice-president, software development, at Spinnaker Software Corp., Cambridge. . . . **Jonathan Delatizky,** Ph.D.'82, was a speaker at the Engineering in Medicine and Biology Chapter of the Boston Section, IEEE, late in the winter; his topic: quantitative analysis of gait. Delatizky is associate director of the Gait Analysis Laboratory at Children's Hospital, Boston, with principal interests in the biomechanics and control of human movement and the relationships between human and robot motion.

Charles W. Merriam, Sc.D.'55, professor of electrical engineering at the University of Rochester, and a specialist in computing engineering and digital image processing, has been elected a fellow of IEEE, cited "for contributions to optimal control theory and its its application." . . . **Alan J. Simmon,** S.M.'48, is group leader of the Antenna Group, Communications Division at M.I.T. Lincoln Laboratory, Lexington, Mass. Simmon's group is currently involved in building an experimental satellite communications package operating at 44 gigahertz (uplink) and 20 gigahertz (downlink); his special interest is in antenna design for both the satellite and the terminal.

David I. Caplan, S.M.'60, former senior vice-president for technical operations at Fortune Systems Corp., Redwood City, Calif., has been promoted to executive vice-president. . . . **Karl I. Selin,** Sc.D.'55, writes, "I am responsible for the power supply to the EEC Euratom Fusion Flagship JET (Joint European Torus) near Oxford, England. The hydrogen plasma volume is the largest one being confined in a magnetic bottle of the Tokamak type. The magnets are supplied from a hybrid system of flywheel generators (400 MV peak power) and the English 400 kV electric power grid (575 MW pulse power)." He reports that the international team of 400 physicists and engineers assembled for the project will return to their original places of work upon its completion by 1990. For Selin, that will be the Royal Institute of Technology, Stockholm, Sweden. . . . Colonel **David L. Carlstrom,** S.M.'69, U.S.A.F., has moved to Griffiss Air Force Base in New York. Carlson, chief of the Command and Control Division with Rome Air Development Center, was previously assigned at Andrews Air Force Base, Md.

Louis M. Boisvert, '53, of Quebec, Canada, died in an automobile accident on October 10, 1981. At the time of his death he was professor of electrical engineering at Laval University, Quebec.

VI-A Program

In March, as this is being written, the companies participating in the VI-A Program have just completed 1,058 student interviews during their two days on campus. Two hundred and twenty-eight students applied for admission this spring—a record number of applicants. The number of interviews could have been higher had there been additional space available at the Institute in which to conduct them. This year's applicants represented 57 percent of the current sophomores in Course VI, up from the average of previous years but down from last year's sudden peak of 63.4 percent.

The companies made available to VI-A students a record 146 openings, but the department is determined to bring total VI-A enrollment down to about 250, a level it considers manageable given the size of the current faculty. Hence, this year's entering VI-A class will number approximately 95 (last year it was 109). Several VI-A alumni/ae interviewed for their companies: **Dean R. Collins,** '58 (Texas Instruments); **Joel A. Feldman,** '79 (Lincoln Laboratory); **Nancy M. Hartle,** '80 (Honeywell Electro-Optics Division); **Theodore M. Lyszczarz,** '74 (Lincoln Laboratory); **L. Allen Snyder,** '73 (Hewlett-Packard Labs); and **Sayuri P. (Kuo) Tung,** '81 (ROLM Corp.).

The passage of time is brought forcefully to mind when an alumnus who, during his student days, became a friend of the VI-A Director and now has a son applying to the program. Such is the case of **Thomas H. Crystal,** '59, whose son, **Michael R.,** '87, is an applicant. Mike, who is on the department's Student-Faculty Committee, interviewed John Tucker in connection with an article about VI-A for the student newspaper.

At a February Tau Beta Pi initiation banquet held at the Cambridge Hyatt-Regency, John Tucker happened to meet **Lawrence Kernan,** '75, in the lobby. Larry mentioned that he expects to be married in July. A surprise visitor during our February 15 Student Open House was **James Hu,** '71. Jim has received his M.D. degree and now practices dermatology in Seattle. . . . **Chester M. Day, Jr.,** '57, came by to talk with Director Tucker about getting VI-A students involved with Bell Communications Research (first called Customer Services Organization, or CSO), part of A T & T's breakoff from Bell Labs, where Chet is now employed.

Other visitors signing our VI-A guest book, include: **Leonard N. Evenchik,** '77, now in business for himself in Cambridge; **Edward C. Giaimo,** '74, who's with Zetron, Inc. in Bellevue, Wash.; **Timothy L. Hoskins,** '79; **James A. Roskind,** '79, who received his Ph.D. in September 1983 and is now with Harris Corp., Palm Bay, Fla.; **Lynn M. Roylance,** '72, with Hewlett-Packard Labs, Palo Alto, Calif.; **S. Dana Seccombe,** '70, with Hewlett-Packard in Ft. Collins, Colo., and a team leader for H-P's M.I.T. recruiting; and **Allen K. Wells,** '80, with General Computer, Cambridge, and who tells us he is now engaged.—John A. Tucker, Director, VI-A Program, Room 38-473, M.I.T., Cambridge, MA 02139

VII

Biology

Two major awards came to members of the faculty at M.I.T. late last year:

□ **Robert A. Weinberg,** professor of biology, shared with Professor J. Michael Bishop of the University of California the Massachusetts General Hospital's Warren Triennial Prize for excellence in medical research. Both winners were cited for "important and innovative contributions to the field of the causation of cancer."

□ **Susumu Tongegawa,** professor of immunology and cell biology, was one of six winners of $15,000 Gairdner Foundation International Awards for his contributions to genetic science.

□ Dr. **Harriet L. Hardy,** who was director of occupational medicine at M.I.T. from 1949 until her

retirement in 1979, and has completed her memoirs, now published under the title *Challenging Man-Made Disease* (Praeger Publishers, $24.95). The book records Dr. Hardy's experiences in 40 years dedicated to identifying and fighting work-related health hazards, including beryllium, cadmium, lead, mercury, arsenic, and asbestos.

S. E. Luria

Anthony Lewis of the *New York Times* is enthusiastic about *A Slot Machine, A Broken Test Tube*, the autobiography of Institute Professor Emeritus **Salvador E. Luria** published this spring by Harper and Row, New York ($17.95): ". . . rare insight into a great spirit, great in science and in humanity, and I learned a lot about both subjects from Professor Luria's candid, quirky observations on his profession and on his life."

Professor **Susumu Tonegawa,** in the department and the Center for Cancer Research at M.I.T., has received a prestigious "Bunkakorosha" (Person with Cultural Merit) Award from the Japanese government. The award is given to Japanese citizens chosen from all fields of science and art for unusual contributions to culture in general. It provides a lifetime annual income, and winners are honored by an audience with the emperor.

VIII

Physics

Professor **Harald A. Enge,** in the department at M.I.T., has received the American Physical Society's 1984 Tom W. Bonner Prize in Nuclear Physics, cited for "outstanding contributions to the design of magnetic spectrometers and beam optics." . . . Institute Professor Emeritus **Jerrold R. Zacharias,** now holds the 1983-84 bronze metal of the International Commission for Physics Education its bronze 1983-84 medal. Zacharias was honored for his "long and distinguished service to physics education" and for being "a teacher of teachers." . . . **Kosta Tsipis,** co-director of the M.I.T. Program in Science and Technology for International Security, is the author of *Arsenal: Understanding Weapons in the Nuclear Age*, published by Simon and Schuster. The book "is the first to make public and accessible the critically important information required for a real understanding of nuclear weapons and warfare," says the publisher.

John M. Andrews, Ph.D.'64, has been named distinguished member of the technical staff at Bell Laboratories, Murray Hill, N.J. The citation honors members of the staff with ten or more years of experience who have records of sustained significant individual contribution to Bell Laboratories' work. Andrews has been recognized for metallization schemes to form Ohmic contacts to silicon integrated circuits and Schottky barrier properties of metallic silicides, for which he is recognized as one of the foremost authorities in the field.

IX

Psychology

Tomaso Poggio, a specialist in artificial and biological vision who is associate professor in the department at M.I.T., is head of a new Center for Biological Information Processing in the Whitaker College of Health Sciences, Technology, and Management. The program's goal is a better understanding of the complex processes that all of us take for granted in such deceptively simple tasks as seeing and moving. Dr. Poggio, who came to the Nuerosciences Research Program in 1979 from his native Italy, will continue his association with the Artificial Intelligence Laboratory.

Richard M. Held, professor of experimental psychology at M.I.T. and department head, received an honorary doctorate of the Free University of Brussels, Belgium, during ceremonies for the 150th anniversary of the university's founding.

X

Chemical Engineering

Most chemical engineers write books about reactions, processes, and economics. But not **Jonathan E. Starr,** who expects his master's degree from Course X in about a year. He's now completed and has on the market a 128-page directory of public and private human service providers in Greater Boston—$10.95 from the Harvard Coop. Starr, who received a bachelor's degree in economics from Harvard in 1978, has been a human services volunteer for many years, sensed the need for a directory, and went to work. It's already sold several thousand copies, and Starr figures he has recouped his expenses and begun to make a modest profit.

Associate Professor **Robert A. Brown,** in the department at M.I.T., has been awarded a Camille and Henry Dreyfus Teacher-Scholar Grant for 1984. Brown plans to use the grant to start new research in small-scale solidification phenomena and to support the writing of a textbook. . . . **Dean R. Thacker,** S.M.'50, former president and director of the Quigley Co., Inc., a subsidiary of Pfizer, Inc., has become president of Pfizer's Minerals Pigments and Metals Division. . . . **P. L. Thibaut Brian,** Sc.D.'56, vice-president for engineering of Air Products and Chemicals, Inc., Allentown, Penn., has been named a fellow of the American Institute of Chemical Engineers. Brian was on the facutly at M.I.T. for 17 years prior to joining Air Products in 1972; he is author of more than 50 technical publications and of a textbook, *Staged Cascades in Chemical Processing*.

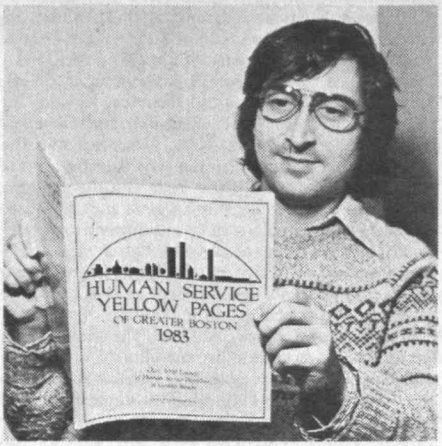
Richard A. Conway, S.M.'57, a corporate development fellow with Union Carbide, received the a 1983 Willem Rudolfs Medal by the Water Pollution Control Federation for the a paper "Improved Thermal Sludge Conditioning by Treatment With Acids and Bases," which he co-authored. The paper was noted as opening a new approach to energy and time constraints presently imposed on the sludge thermal conditioning process. . . . **C. Judson King III,** Sc.D.'58, dean of the College of Chemistry and professor of chemical engineering at the University of California, Berkeley, has been elected a fellow of AIChE. King is cited for research in freeze drying, spray drying and solvent extraction, resulting in over 100 technical publications and two textbooks; as a founding board member of the Council for Chemical Research; and as recipient of the AIChE's William H. Walker Award.

Eugene L. Grumer, S.M.'64, reports, "I was promoted in October to the Woodbridge office of Amerada Hess as administrative assistant to our vice-president of refining." . . . **Thomas H. Goodgame,** Sc.D.'53, director of environmental control for Whirlpool Corp., Benton Harbor, Mich., has been honored with the Porcelain Enamel Institute's President's Award. The citation is "for leadership, technical expertise, dedication and tenacity on behalf of the porcelain enameling industry in its long and ultimately successful efforts with the U.S. Environmental Protection Agency in developing realistic and achievable effluent regulations."

XI

Urban Studies and Planning

The Program on Negotiation, an interuniversity consortium of which Professor **Lawrence E. Susskind,** Ph.D.'73, of M.I.T. is executive director, has been funded with a three-year $500,000 grant from the William and Flora Hewlett Foundation of Menlo Park, Calif. The program, based at Harvard Law School, embraces Harvard, M.I.T., and Tufts projects in the field of dispute resolution and negotiation—including the Public Disputes Program organized by Susskind at M.I.T. Goals of the consortium are to offer studies in conflict analysis and resolution, build a research library, and become a clearing house for information and case studies.



Jonathan E. Starr is not your typical chemical engineer—even though he expects a degree in the field from M.I.T. by 1985. Starr, having done lots of volunteer human services work, decided that a comprehensive directory would be helpful to those who provide services as well as those who need them.

We learn belatedly that **Harvey B. Gantt,** M.C.P.'70, was elected mayor of Charlotte, N.C., last November. *Time* magazine called it "the most heartening black success" in the November elections, and one Charlotte businessman is quoted as characterizing Gantt as ". . . very thoughtful . . . fiscally conservative."Before coming to M.I.T., Gantt was the first black graduate in architecture from Clemson; his term as mayor follows six years' service on the Charlotte City Council.

Frederick L. Merrill, Jr., M.C.P.'80, writes, "Currently working for Sasaki Associates, Watertown, Mass., which is a multidisciplinary planning/design firm (planning, urban design, architecture, landscape architecture, engineering and environmental services). I am working in the planning group as an urban planner and real estate feasibility analyst for a wide variety of public/private clients on planning and land development projects." . . . **William B. Singleton,** '40, reports that he is a member of the St. James Vestry and the Evangelical Committee of the Episcopal Diocese of Los Angeles, and that he is active on the board and an historian of the Los Angeles Chapter of the Sons of the American Revolution. A tree farmer near Los Angeles, he is a member of the Lions Club and maintains his membership in the American Planning Association.

William E. Barbour, M.C.P.'57, reports that on January 31 he retired from the service with the U.S. Department of Housing and Urban Development, Hartford, Conn. He will continue to reside in Bristol, R.I., and will donate his fulltime toward efforts to end the nuclear arms race. . . . **Alan Rabinowitz,** Ph.D.'69, reports that he is principal in a new firm, Territory Research, Inc., Seattle, Wash., advisory services in land use and economic development.

Francis T. Ventre, Ph.D.'73, former senior research architect with the Center for Building Technology at the National Bureau of Standards, is now director of the Environmental Systems Laboratory and professor of environmental design and policy in the College of Architecture and Urban Studies at Virginia Tech, Blacksburg. . . . **Philip Shapira,** M.C.P.'79, is completing his doctoral dissertation on "Industrial Restructuring and Responses to the Reorganization of Work" at the Department of City and Regional Planning at the University of California, Berkeley. . . . **John Vialet,** M.C.P.'64, writes, "I am currently deputy associate director, Law Enforcement Programs, for the United States General Accounting Office—the 'watchdog of Congress'—but this is going to change momentarily. I'm finishing up GAO's senior executive development program and don't know what my next assignment will be. Regards and best wishes to all my classmates." . . . **John Blackwell,** M.C.P.'47, reports, "Helped by a marvelous pair of presidents and fellow directors, Boston Natural Areas Fund, Inc. (1980), keeps me busy securing and protecting green acres, mainly in Boston. We are happy to have been some help also in New Haven, Cincinnati, Dayton and Rochester."

Parviz S. Towfighi, Ph.D.'70, is the former adviser to the Ministry of Housing and Urban Development of Iran and a lecturer in urban and regional economics at the University of Tehran. He is currently with the United Nations Centre for Human Settlements, working on two research programs: bilateral and multilateral aid in the field of human settlements; and human settlements in the year 2000. In October 1983 he participated in an ECE seminar in Budapest presenting a paper suggesting the development of a global spatial planning model.

XII

Earth, Atmospheric and Planetary Sciences

Robert M. White, Sc.D.'50, president of the National Academy of Engineering, was honored late last year with the Delmar S. Fahrney Medal of the Franklin Institute of Philadelphia. The medal is awarded "for outstanding leadership in science and technology," and Dr. White was cited for "dynamic, creative, inspiring, and successful leadership of research and development of an operational weather satellite network, the integration of oceanographic and meteorological activity in the civilian sector of the U.S. government, and the maturation of research and operational programs in numerical weather prediction."

Mrinal K. Sen Gupta, Sc.D.'75, writes from Houston that he is "actively engaged in Exxon's research to develop 'direct indication of hydrocarbons using seismic data.' Since June 1982, my position has been senior research specialist."

J. Douglas Brawner, S.M.'43, of Midland, Tex., passed away on September 18, 1982; no details are available. . . . **John R. Charles,** '35, retired vice-president of International Water Corp., Pittsburgh, Penn., passed away on September 30, 1982 in Islamorada, Fla. . . . **Orville Frank Tuttle,** Ph.D.'48, of Tucson, Ariz., passed away on December 13, 1983; no details are available.

XIII

Ocean Engineering

Professor **Dick K. Yue,** '74, holds the Doherty Professorship in Ocean Utilization for 1984—a two-year appointment under funds that are designed to promote research on current problems in ocean science. Yue, who received his doctorate in civil engineering at M.I.T. in 1980, will study second-order wave effects. His goal is to improve their understanding so that such wave effects can be incorporated into engineering designs for offshore platforms and other marine facilities.

Captain **Nicholas A. Draim,** '25, U.S.N.(Ret.), has been made a life member of the U.S. Naval Institute. Draim, who is now living in his original home town of Vincennes, Ind., attended the U.S. Naval Academy and holds an LL.B. degree from Georgetown Law School. His distinguished Naval career includes service with the commander of fleet aircraft in the South Pacific during World War II and later assignments as senior naval attache and naval attache for air in the American Embassy, Moscow. He has also served as law officer, trial counsel, and defense counsel for general courts martial in the U.S. armed forces, and was a member of the bar before the U.S. Supreme Court.

Donald P. Courtsal, S.M.'56, former vice-president and treasurer of the Dravo Corp., Pittsburgh, Penn., has become the firm's senior vice-president, manufacturing group. . . . **John M. (Monty) Ballinger,** S.M.'41, has sent a write-up of his three-month trip (with his wife and another couple) to Taiwan last fall under the auspices of International Executive Service Corps, to help the China Shipbuilding Corp. increase its profitability. "Most of the time was spent on the company's main yard at the southern tip of the island. Their facilities are excellent; the building dock is the second largest in the world, with capacity for constructing six good-sized merchant ships (two abreast) and with capacity for two more for repair with an outer caisson. . . . The last month we lived in Taipei, commuting (a one-hour trip) to the yard in Kuling. This is an older yard, having been built during the Japanese occupation, and is suffering with maintenance problems. . . . The workers at both yards are very industrious and hard-working. The last week we spent with the United Ship Design and Development Center, the contract plan design group. . . . We also had a weekend in Tokyo on the way over and stayed a few days in Hong Kong, Bankok, Singapore, New Delhi, and Rome on the way home. Quite a trip!"

Leonard Kaplan, S.M.'26, a retired captain in the U.S. Navy, passed away in Livingston, N.J., on May 5, 1983. Kaplan, a veteran of World War I and II, earned several medals and citations, including two Legions of Merit. During World War II he was stationed in Iceland as repair and materials officer of the naval operating base in Reykjavik, and later he was sent to San Diego as production officer of the Industrial Command. Following retirement from the naval service in 1949, Kaplan joined the Foster Wheeler Energy Corp., Carteret, N.J., then in 1964 returned to naval architecture with M. Rosenblatt and Son, New York City.

XIV

Economics

Paul Osterman, Ph.D.'76, associate professor of economics at Boston University, is the editor of a new collection of papers on internal labor markets, industrial relations, and company heirarchies published last month by the M.I.T. Press. The topic's importance derives from the fact that, contrary to popular images, most Americans spend most of their working lives employed in a single firm. Employment practices and government regulations affecting these people are changing—hence the interest in *Internal Labor Markets*.

Robert E. Hall, Ph.D.'67, professor of economics at Stanford, was co-author late last year of a *Wall Street Journal* report that is credited with starting the upsurge of interest in the "flat tax." He's a senior fellow at the Hoover Institution in Palo Alto, where the flat tax concept originated in the 1960s.

Maud Naroll, Ph.D.'81, assistant professor of economics at Dartmouth College, Hanover, N.H., was awarded an Indo-American Fellowship of the Council for International Exchange Scholars for research in economics at the Delhi School of Economics, India, for four months last winter. Prior to joining the Dartmouth faculty, Naroll taught development and labor issues at the University of North Carolina, Chapel Hill, and conducted research for the World Bank.

High Tech: No Panacea for the Midwest

Can high tech be the solution to the dreary economic doldrums of the Great Lakes states?

Perhaps, says Lynn E. Browne, Ph.D.'80 Econ., vice-president of the Federal Reserve Bank of Boston. But it won't happen by transforming the Great Lakes states into another New England, where high-tech industry kept the 1981-83 recession at bay.

High tech can best help the midwest by assuring the nation's ability to use what the midwest does best—durable goods manufacturing, Browne says in the Federal Reserve's *New England Economic Review* (November/December 1983).

High-technology industries are now a very modest factor in the Great Lakes states' economy—well below the U.S. average in Michigan, Ohio, and Wisconsin, barely average in Illinois and Indiana. To make high technology account for the same proportion of jobs in the Great Lakes as it now does in New England and California, high-tech employment in the midwest would have to triple. Such an increase would represent more than 20 percent of the total U.S. high-tech employment, and "there are simply not enough high-tech jobs to go around," writes Browne.

Most new high-tech industries grow out of old ones, and they tend to stay where their founders start them. To attract new high-tech industries the Great Lakes would have somehow to overcome this inertia, and they've few advantages to bring to that effort. The proportion of the Great Lakes workforce in professional and technical occupations is below the national average—14.6 percent compared with 15.5 percent (national) and 17.7 percent in New England (1980 figures). The Great Lakes states' labor force is not a highly educated one—the proportion of residents with college degrees (14.5 percent) is lower than in any other part of the U.S. except the southeast. And Massachusetts and California institutions have commanding leadership in advanced degrees in science and engineering.

Average manufacturing wages and salaries in the Great Lakes states are "substantially" higher than in Massachusetts or California, says Browne, with Michigan 26 percent above the national average and 33 percent above Massachusetts. High wages are not characteristic of high-tech industries, and expansion into the Great Lakes would mean competition for labor with

Continued on page A22

local industries whose wages are high. Furthermore, union membership is high in the Great Lakes states, while most high-tech companies are nonunion. High-tech managers "may be reluctant to open branches in an area where unionization is the norm," speculates Browne.

If not high tech, then what can bring prosperity to the Great Lakes? Better performance in the smokestack industries, expansion into new sectors other than high technology, and decreasing the labor force through out-migration.

"High tech is more likely to save the Great Lakes states by preserving jobs in traditional industries than by transforming them into another New England," writes Browne. □

XV

Management

A new structure for undergraduate study in the Sloan School will go into effect next fall, leading to a new degree designed as an S.B. in "management science." In addition to a required core of subjects, according to Professor Alvin J. Silk, associate dean, students will take three to five courses in one of four optional fields—information systems, marketing, operations research, or behavioral science. Dean Silk says the new "management science" emphasis responds to high demand—in the past decade the existing program in that field has been far more popular than Sloan's other undergraduate offerings. The information systems option is new, reflecting the growing dependence of management on computers and telecommunications. And the school hopes it will attract students from the overcrowded Department of Electrical Engineering and Computer Science.

Kendrick B. Melrose, S.M.'65, is president and chief executive officer of the Toro Co., Minneapolis, Minn. . . . **John C. Reid,** S.M.'74, is vice-president of operations for the Coca-Cola Co., Atlanta, Ga. . . . **Caren E. Kelman,** S.M.'79, is currently marketing manager at Digital Research, Pacific Grove, Calif., living in Carmel, and invites travelling Sloan classmates to call for a visit. . . . **Carol M. Taylor,** S.M.'82, writes, "Became senior consultant for Mitchell and Co. in January 1983—commuted from Cambridge to Menlo Park, Calif. (February to June 1983)—helping open new company office . . . and my daughter Anna was born on August 8, 1983."

James J. Forese, S.M.'59, has been made corporate vice-president and controller at International Business Machines Corp., Armonk, N.Y. . . . **Fred Shinagel,** S.M.'55, former managing director of Laidlaw Adams and Peck, Inc., has become managing director of Dean Witter Financial Services, Inc., a subsidiary of Sears, Roebuck and Co., Chicago, Ill. . . . **Valerie B. Klaiman,** S.M.'81, reports, "I am an investment analyst for Fechtor, Detwiler and Co., Inc., a private brokerage firm in Boston. I am married to Daniel Fleischer and we own a 100-year-old carriage house in Newton." . . . **R. Scott Morgan,** S.M.'76, is director of domestic airline finance at McDonnell Douglas Finance. . . . **Giyora Doek,** S.M.'58, writes, "I am delighted to be working (or is it playing?) with a fine group of about a dozen Sloan alumni volunteer coordinators. We are getting together about once a month, were pleased to have a dinner meeting with Dean Siegel recently, and are planning another with Ed Roberts in April."

Robert W. Norris, S.M.'63, writes, "After many years in business, primarily in Scandinavia, I shifted careers in 1981 and after two of training (1979-1981) I became an elementary school teacher in a Rudolf Steiner School here in Great Barrington, Mass." . . . **Philip A. Ellis,** S.M.'79, is president of Anderson Exploration Group, a new oil and gas exploration company. . . . **Stanley Zalkind,** S.M.'64, former senior vice-president at Electro Audio Dynamics, Inc., Great Neck, N.Y., has been promoted to president and chief operating officer. . . . **Davis P. Thurber,** S.M.'48, board chairman and president of the New Hampshire Corp., has recently been elected to the board of directors of the Pennichuck Water Works. Thurber is a director of the Whitney Screw Co. and Energy North, Inc., and a trustee and treasurer of Nutt Hospital.

Chi-Yuan Lin, Ph.D.'68, chairman of the Decision Systems Department in the University of Southern California School of Business Adminstration, has been re-elected to a three-year term in the Senate of the Republic of China. Lin joins 26 other overseas senators elected to represent ethnic Chinese abroad . . . he is one of five "at large" senators—the only one in the Western United States.

Professor **Fischer Black,** a member of the Sloan School faculty since 1975, whose research has focused on the behavior of economic and financial markets, has joined the Wall Street firm of Goldman, Sachs and Co. On leave from M.I.T. Black will assist equity traders in using options and futures to hedge against risk. Black is widely known as a Wall St. technical analyst specializing in the pricing of call options.

Thomas L. Mays, S.M.'77, is currently senior manager of terminal engineering, MCI Telecommunications Corp., Washington, D.C. . . . **John A. Mazzarino,** S.M.'77, left Peat Marwick Mitchell & Co., Washington, D.C., about two years ago and is now enjoying his work as a consultant with Bain & Co., a strategy consulting firm in Boston. . . . **Edward Keon, Jr.,** S.M.'79, is currently an industry manager of office products for Information Management Group, Morristown, N.J., (a subsidiary of Control Data Corp.), a marketing consulting firm. . . . **Richard H. Grueter,** S.M.'78, was promoted to audit manager of Price Waterhouse in July 1983. . . . **Barbara Lewis,** S.M.'71, is on the faculty at the University of Manchester, England, and is editor of the recently launched *International Journal of Bank Marketing*.

Paul M. Konnersman, S.M.'67, has recently joined Goodmeasure, Inc., Cambridge, a consulting firm, as senior vice-president. . . . **William M. Fondren,** S.M.'63, writes that he has been elected to the Board of Directors at Liberty Distributors, Inc.; elected to the Executive Board of the National Wholesale Hardware Association; and elected by hardware manufacturers as "Hardware Merchandiser of the Year" (election sponsored by *Hardware Merchandiser* magazine). . . . **John L. French, Jr.,** S.M.'71, has recently returned to the Department of Management at the University of Texas in Arlington from Sao Paulo, Brazil, where he lectured and did research on labor-management relations as a Fulbright Fellow. . . . **John W. Starke,** S.M.'68, has been appointed managing director of Westchester (N.Y.) Mortgage Co., a subsidiary of Peoples Westchester Savings Bank. . . . **Paul R. Freshwater,** S.M.'68, is currently regional manager of state and local government relations for Procter & Gamble Co.; he's also vice-president of the Charter Committee of Greater Cincinnati.

Thomas C. Thompson, S.M.'57, vice-president of Studwell Associates, Boston, a research and consulting firm, was killed on October 28, 1983 in an airplane crash on a test flight in Littleton. Thompson, a pilot of 30 years' experience served as a glider pilot instructor for the M.I.T. Soaring Association, and was a pilot for Northeast Airlines in the early 1950s. He was also a registered professional engineer, spending many years in the Coast Guard and Naval Reserve. . . . **Percy F. Hurt,** S.M.'39, of Windermere, Fla., passed away on May 30, 1981, while traveling in Spain. . . . **Stewart J. Hungerford,** S.M.'33, associated with Bethetex Industries, Ltd., Victoria, Canada, passed away in December 1979. . . . **Charles Gilman, Jr.,** S.M.'54, of the Gilman Paper Co., New York City, passed away in January 1982.

Sloan Fellows

Robert J. Flautt, S.M.'70, former vice-president and treasurer of the Whirpool Corp., Benton Harbor, Mich., has been promoted to senior vice-president and treasurer. . . . **Ormand J. Wade,** S.M.'73, late last year was made president, chief operating officer, and chief executive officer at Illinois Bell Telephone Co., Chicago. . . . **William G. McGagh,** S.M.'65, is presently senior vice-president of finance and director at the Northrop Corp., Los Angeles, Calif.

Carl H. Janzen, S.M.'74, former vice-president and group executive at the Burroughs Corp., has recently joined Spartacus Computers, Inc., Bedford, Mass., as president and chief operating officer; he succeeds **George C. McQuilken,** '65, in that post. . . . **Frederick F. Sommer,** S.M.'80, has been appointed to vice-president of engineering and planning at Nissan Motor Manufacturing Corp. U.S.A., Smyrna, Tenn. Sommer joined Nissan in 1981 as plant manager of the Body, Frame and Stamping Plant. Prior to joining the firm, he held several management positions with the Ford Motor Co. in Chicago, Ill., and Woodhaven, Mich. . . . **Richard J. Santagati,** S.M.'79, has been named president of NYNEX Business Information Systems, White Plains, N.Y., a newly formed subsidiary of NYNEX. Santagati joined New England Telephone in 1965 as a supervisory assistant in the operator services department, then was promoted to vice-president for marketing, and most recently became vice-president of marketing for the NYNEX Service Co.

Robert S. Ames, S.M.'54, retired on January 31, 1984, as executive vice-president of Textron, Inc., Providence, R.I. . . . **David A. Lewis,** S.M.'67, is president and chief operating officer at the Continental Bank of Canada, Toronto. . . . **Hollis L. Caswell, Jr.,** S.M.'68, former vice-president of the Technology Products Division at IBM Corp., has become vice-president of special programs at Burroughs Corp., Detroit, Mich.

Herbert H. Meyers, S.M.'80, former senior vice-president for establishment marketing and sales for Diners Club International, has recently joined Seligman & Lantz, Inc., New York City, as president and chief executive officer of their New Business and Development Group. Meyers will be responsible for reviewing new business opportunities which fit into the firm's corporate organization as well as expanding their free-standing beauty salon business. . . . **Ann S. Peterson,** S.M.'80, has moved from New York City to Chicago, Ill. . . . **Emmett J. Horton,** has returned to Ford Motor Co. in the United States as director/technical staffs, after five years in Europe with Ford of Europe as director of their North American Research/Liaison office. . . . **Donald H. White,** S.M.'70, was elected president of Hughes Aircraft Co. in April 1983. . . . **R.L. Youngdahl,** S.M.'63, reports, "October 1, 1983 I retired from Consumer Power Co., both as executive vice-president and from its board. Although I've formed a new company—RAM—both Mary and I are looking forward to a new chapter in our lives."

Philip A. Campbell, S.M.'70, has been elected president of of Bell Atlantic Management Services, Inc., Arlington, Va., and will also serve as director of the Bell Atlantic Corporation. . . . **Patrick Le Feuvre,** S.M.'80, is currently product manager of the Military Department of Texas Instruments, France.

E. Quinton Gordon, S.M.'77, has been manager of industry and competitive analysis at United Airlines since 1983. . . . **Joseph F. Rex,** S.M.'58, writes, "I have now retired after 43 years with the Campbell Soup Co. and moved to Paris, Texas, to spend my retirement years."

Roger G. Sweet, '59, of Montgomery, Tex., passed away on October 17, 1983; no details are available.

Senior Executives

Hanns R. Oeser, '76, is currently director of the engineering division of Deutsche Gessellshaft fur

Coming to Sloan? Don't Bring a Numbers Phobia

What's it like to be a Master's student in the Sloan School?

It's just fine, says Maureen Rogers, S.M.'81, who describes herself as "an enthusiastic advocate. . . . A very fine place to go to business school," she writes as Sloan's expert critic in *The Insider's Guide to the Top Ten Business Schools* (edited by Tom Fischgrund for Little, Brown and Co., Boston, 1983).

There was no doubt that the Sloan Master's program would be among Fischgrund's top ten—it's in everybody's list, along with Harvard, Stanford, Wharton, Chicago, and Northwestern, he says.

In his official tabulations, Fischgrund puts the Sloan Master's program near the bottom in enrollment (170, with only Tuck—Dartmouth—smaller at 140), at the top in tuition ($9,600 compared with Chicago's $9,400), and way at the top in average starting salaries of its Master's graduates—$36,000 compared to runner-up Tuck's $33,700.

Fischgrund concludes that Sloan is distinguished especially by its emphasis on numbers. "It's noted for its highly quantitative programs in finance, economics, and information systems," he writes. And most classes require "some capability and facility with figures."

Rogers—she is now a consultant in corporate planning at Chase Econometrics Interactive Data Corp.—doesn't dispute the characterization, but she insists that Sloan "has gone a long way toward distancing itself" from the image of an engineer's management school. Perhaps it has kept what is best of that obsolete image—a rigorous program for which "some quantitative background and ability are absolutely essential," writes Rogers. "Incoming Sloanies should not have severe number phobia."

Sloan is the only one of the 10 that clings to a thesis requirement for all Master's recipients. That's a controversial feature of the curriculum, Rogers says, with an "annual lobbying effort" by students to end it. But in the final analysis, thinks Rogers, "many students actually enjoy the opportunity," and lots of them capitalize on it by choosing topics that require developing contacts—useful for the job search—with the outside business world.

Despite all the rigor and competition, Rogers found the atmosphere of Sloan "surprisingly relaxed and congenial," she reports. "The fundamental, salient features of the Sloan School," she concludes, "are its academic excellence, its quantitative orientation, its informality, and the cooperative and friendly spirit among its students." □

Wiederenfarbeitung von Kernbrennstoffen (DWK), Hannover, West Germany, responsible for conceptual planning of the first German commercial reprocessing plant for spent nuclear fuel. . . . **Donald E. Procknow,** '63, former president of Western Electric, has become vice-chairman and chief operating officer of American Telephone and Telegraph Technologies, New York City. . . . **Charles F. Bischoff, Jr.,** '74, former director of management resources at Allied Corp., Morristown, N.J., has been promoted to staff vice-president. .

William E. Armantrout, '64, has retired from his position of vice-president and regional manager of the Kaiser Aluminum and Chemical Corp., Oakland, Calif. . . . **Joseph A. Baute,** '64, chairman and chief executive officer of the Markem Corp., has been elected director of Nashua Corp., Nashua, N.H.

The following deaths have been reported by the Alumni Association, with no further details available: **Carl A. Julien,** '67, manager of the Engineering Science Department at Deere and Co., Moline, Ill., on January 25, 1976; **John H. Goodloe,** '64, vice-president and general manager of Thiokol Corp., Huntsville, Ala., on September 10, 1982; and **Robert D. Smith,** '59, of Fort Lauderdale, Fla., on February 6, 1977.

James R. Early, '74, vice-president of the Campbell Soup Co. and president of the Campbell Container Co., responsible for containers and capital improvements, passed away in Philadelphia on October 11, 1983. Early, an executive with Campbell for nearly 30 years, was responsible for much of the container company's manufacturing, research, engineering, and equipment development. Early was a lieutenant during the Carlson's Raiders campaigns in the South Pacific in World War II, where he was awarded two Purple Hearts and a Silver Star; was past president of the Washington-based Can Manufacturers Instititue; and director of the Philadelphia Country Club.

Management of Technology Program

Charles A. Berry, S.M.'83, was at M.I.T. in January. Several of the class of 1984 had lunch with him at the Faculty Club, and he met with Ed Roberts. He reports that Irene is pregnant, and they have moved to a new home in North Wales. . . . **Carol M. Lemlein,** S.M.'83, met with the current class while she was at the Sloan School on February 8, recruiting for Teradyne. Ed Roberts reminded me that Carol was written up in Teradyne's newsletter last fall, where her software project management position was described as "at the marketing-technology interface." . . . **Henry M. Montrey,** S.M.'82, was expecting to be at M.I.T. in early April when he was to be lecturing for Jim Utterback's "Manufacturing/Technology Interface" class.

Wilbur (Bill) B. Vanderslice, Jr., S.M.'83, now oversees the manufacturing side of his division at IBM as well, since his boss was recently promoted to vice-president of development and manufacturing. His job only speeds up—never slows down—Bill reports, even though he was forced to nurse an injured achilles heel recently. He and a colleague are working on a paper on the management of long-term technical efforts, based on Bill's Master's thesis. . . . **Elliot S. Blackman,** S.M.'82, is enjoying his recent move to Digital. Since November, he has been in DEC's Hudson, Mass., location working in new business development in data communications and video market areas.—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI

Aeronautics and Astronautics

Bradford W. Parkinson, S.M.'61, vice-president of Intermetrics Co., Cambridge, has been awarded the Royal Institute of Navigation's Gold Medal for 1983. Parkinson served as project manager of the NAVSTAR program and was cited for "his outstanding contribution to navigation in his direction of the NAVSTAR program from its initiation to completion of validation of concept." Parkinson's leadership "was most significant in that it laid the foundations and established the feasibility of a global positioning system."

Peter M. Bainum, S.M.'60, reports that he is executive vice-president of the American Astronautical Society for the term 1982-1984. Also (last December), he presented a series of lectures on the dynamics and control of large space structures at the Japanese National Aerospace Laboratory, the University of Tokyo, the Institute for Space and Astronautical Sciences, and Nippon Telephone and Telegraph Electrical Communications Laboratory. . . . **Charles Joseph Touhill,** S.M.'61, manager of Baker/TSA, Beaver, Penn., the environmental management division of Michael Baker, Inc., a consulting engineering firm, has been named a trustee of the American Academy of Environmental Engineers. Touhill "has managed and been a participant in major environmental projects (and) . . . has performed water and waste management process engineering for the nuclear, steel, chemical, coal, glass, petroleum, and food processing industries."

XVIII

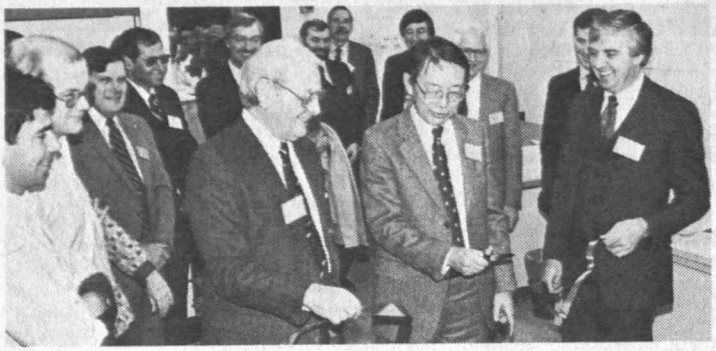
Mathematics

A busy spring for **Tadatoshi Akiba,** Ph.D.'70, associate professor of mathematics at Tufts. He's one of two sponsors of a Norbert Weiner Forum, planned to conduct "a critical analysis of contemporary society and the role of computer technology within it." The forum will help provide the agenda for a new Nikkei Industry Research Institute at Tufts, of which Akiba is a senior fellow.

Stuart A. Geman, Ph.D.'77, associate professor of applied mathematics at Brown University, is the winner of a 1984 Presidential Young Investigator Award. He'll receive $25,000 annually for five years for research on a unified theoretical basis for computer image processing. The goal: allow thousands of microprocessors to work on different portions of an image simultaneously—a development that would have important applications in medical image processing and robotics.

Professor **Bertram Kostant,** in the department at M.I.T., presented the ninety-first series of Colloquium Lectures at the 87th summer meeting of the American Mathematical Society last year at the State University of New York, Albany. "On the Coxeter element and the structure of the exceptional Lie groups" was the title of the set of four lectures. . . . Professor **Richard B. Melrose,** in the department at M.I.T., received the Bocher Prize of the American Mathematical Society at its annual meeting last winter. Melrose was cited "for his solution of several outstanding problems in diffraction theory and scattering theory and for developing the analytical tools needed for their resolution."

John "Jack" Nolan, S.M.'53, president (since 1969), of the Massachusetts College of Art, Boston, who teaches computer graphics and mathematics at the school, gave a seminar last December entitled "The New Technology Impact on Careers in the Visual Arts." . . . **Eric Reissner,** Ph.D.'38, professor emeritus of applied mechanics at the University of California, San Diego, will be presented with the Structures, Structural Dynamics and Materials Award by the American Institute of Aeronautics



Professor James W. Mar, '41, cuts the ribbon to open the new Hall L. Hibbard Computer-Aided Aerospace Design Facility at M.I.T. He's flanked by Morris A. Steinberg, '42, of Lockheed and James Sims of Perkin-Elmer (right), representing the corporate donors of the equipment and software. Hibbard, for whom the facility is named, was an aviation pioneer who rose to become chief executive of Lockheed after graduating from M.I.T. in 1928.

and Astronautics on May 15, 1984. The presentation to Reissner is "in recognition of 50 years of fundamental contributions to the aerospace community as a teacher and researcher in applied mathematics and mechanics of aircraft structures, and for the establishment of the Reissner variational principle." . . . **Philip S. Brown,** S.M.'63, a researcher in the Center for the Environment and Man (CEM), Hartford, Conn., has received a National Science Foundation grant to study rain formation within convective clouds. Brown will study the mathematical equations governing drop collision, a subject of particular importance to agricultural projects in arid regions.

XIX

Meteorology

Robert M. White, Sc.D.'49, president of the National Academy of Engineering, received the Delmer S. Fahrney Medal given by the Franklin Institute last January, for "contributions to the development of an operational weather satellite network for the United States."

Donald E. Ackerman, Sc.D.'41, of Monroe, Ohio, passed away on April 20, 1983; no details are available.

XX

Nutrition and Food Science

Takeo Yasuda, S.M.'64, is chief engineer of Ajinomoto, a Japanese food and biotechnology company. That news comes from **Richard I. Mateles,** '56, vice-president—research at Stauffer Chemical Co., who reports that he and Mrs. Mateles joined Yasuda and **Kiyoaki Katoh** for dinner during a recent Tokyo visit. Katoh, who studied only one year at M.I.T., is a scientist with the National Food Research Institute; he had recently returned from a government assignment in Indonesia.

Charles L. Cooney, professor of chemical and biochemical engineering at M.I.T., received the 1983 Food, Pharmaceutical and Bioengineering Division Award of the American Institute of Chemical Engineers, recognizing his development of fundamental strategies for computer control of fermentation processes and other work in areas of biotechnology as researcher, educator, and author. . . . **Barbara J.S. Greenberg,** reports, "In February 1983 I was appointed nutrition director of the Special Supplements Food Program for Women, Infants, and Children (WIC) with the New York State Department of Health. The state WIC program has a current operating budget of $120 million with $2.6 million specifically allocated for nutrition education services. I am responsible for the nutrition education component of the program and supervise a staff of eight nutrition education consultants, who in turn provide technical assistance to 86 local WIC projects. I am involved with interpretation of federal regulations, development of policies and evaluation of program impact on the health status of WIC clients. I find my job extremely challenging and very rewarding. My M.I.T. training in nutrition planning (INP Program), nutritional biochemistry, and clinical nutrition has prepared me for many of the demands of my new position."

XXI

Humanities and Social Science

From the New England Conservatory of Music has come a new commission for **Peter Child,** visiting scholar in experimental music at M.I.T. He's one of six winners in the conservatory's "New Works" Program, and he'll write a work for performance by the conservatory's Contemporary Ensemble during the winter or spring of 1985.

Professor **John Harbison**'s First Symphony was given its premier performance on March 22 by Seiji Ozawa (to whom it's dedicated) and the Boston Symphony Orchestra. Harbison will be composer-in-residence with the Boston Symphony at Tanglewood next summer, and then he'll be back at M.I.T. after a two-year leave to be composer-in-residence with the Pittsburgh Symphony. On that subject Andre Previn of the Pittsburgh Symphony is enthusiastic: "If I had my way, I'd keep (Harbison) here indefinitely."

Jean Elizabeth Jackson, assistant professor of anthropology, spent part of the summer of 1983 in El Salvador and Nicaragua, a trip for a faculty group sponsored by an organization called Faculty for Human Rights in El Salvador and Central America. In a recent issue of *The Cheney Room Papers* (a newsletter for women at M.I.T.), she describes her visit to the National University of El Salvador in the city of San Salvador: "The campus looks like today a ghost town. Weeds grow through the cracks in the building walls; a burned tree trunk has fallen across the walk near the main entrance; army patrols guard the gates. You must ask permission of the army to enter and you may be told, "there is nothing to see; it is empty." Upon entering, you take a tour that at times reminds you of a futuristic science fiction film, where the effects of some cataclysm are suggested by showing the institutions of a once thriving society—deserted and decaying. At the National University, you wander through halls where all equipment used to train future dentists has been ripped out, except for a few stripped chairs. At the faculty of medicine you look in formaldehyde vats at cadavers which have been waiting two years to teach gross anatomy to medical students. At the library, in many respects equivalent to our Library of Congress because it serves as El Salvador's national archive for many documents, you see books on the floor, torn up, sprinkled with bat feces.

In a separate interview, Janice Eisen, '85, of *The Tech* asked Professor Jackson about the future of education in San Salvador. "Totally bleak and unpromising," was Jackson's reply. "The university stands for people who feel a responsibility to criticize government abuses, and the government does not tolerate that. . . . It's clear that the university campus is not going to be opened for quite a while—at least until elections next year, and I think that's a very serious indictment of the present regime in El Salvador."

XXII

Nuclear Engineering

John R. Woberg, Ph.D.'62, writes, "My recent book *Conversion of Computer Software* was published by Prentice Hall in 1983." . . . **Richard E. Storat,** S.M.'67, is manager of corporate energy affairs for the Bethlehem Steel Co. . . . **Timothy S. Jenks,** S.M.'78, resigned from the U.S. Navy last October and is currently enrolled as a first-year student at Stanford University Graduate School of Business (M.B.A.'85)

Peter B. Roemer, Ph.D.'83, is an electrical engineer at the General Electric Research and Development Center, Schenectady, N.Y. . . . **K. Keith Roe,** S.M.'74, executive vice-president of Burns and Roe, Inc., Oradell, N.J., has taken on the additional responsibility of chief operating officer.

Frank A. Russo, S.M.'58, a nuclear engineer at the Martin Marietta Corp., Baltimore, Md., passed away on April 8, 1981; no further details are available.

Technology and Policy Program

Professor **Nicholas A. Ashford,** director of M.I.T.'s Center for Policy Alternatives who is an affiliate of the Technology and Policy Program is a member of Massachusetts Governor Michael S. Dukakis' Energy Advisory Board, to assist in formulating energy policy and predict energy use and supply in Massachusetts. . . . **Olimpia Hernandez,** S.M.'84, has accepted a position with T-Bar, Inc., where she will be working in the area of fiber optic research and development. . . . **Jay Lingamnei,** S.M.'82, has accepted a position with Automated Assemblies, Clinton, Mass. . . . **Amarquaye Armar,** S.M.'78, has been promoted to energy planner in the UNDP/World Bank Energy Assessments and Sector Management Program. . . . **Samer Faraj,** joined a U.S.AID mission to North Yemen as a consultant last March, and in May he will attend a major international energy conference in Israel where he will present a paper on energy planning for small-to-medium-sized oil-importing countries.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

Diana ben-Aaron

Continued from page A2

quite like the music John puts before them. They may have joined the band with something quite different in mind. But that's no handicap; indeed, they're soon enough won over, and they find that everyone is welcome: students, staff, alumni, community. John Corley has always had a policy of open rehearsals so that in fact the musicians select themselves.

Under these circumstances, the ability to play a band instrument is not always a prerequisite. Ken Ballou, '83, learned percussion by joining the band. "I'm really a pianist," he says, "but there are so many pianists that no one wants us. So last year when I heard that the Concert Band needed someone who could read music and play zylophone and chimes, I said I'd join. It was a case of pick up the mallets and get in there and figure it out as you go along. . . ."

While some of the band's 65 musicians are of professional quality, all are amateurs in the sense of playing for the love of it. For the most part, we are students or practitioners of science and engineering, and the success of the band depends on our ability to apply to music the concentration and judgment that characterizes those professions. (In my case, this usually means knowing when to keep quiet so as not to damage the efforts of the rest of the flute section!)

Although it is not very widely played, the repertoire of original music for band is not as small as it was in 1953. That's partly because the Concert Band commissions a new piece every year. Another reason is that members and alumni of the band have caught the composition bug. As an undergraduate Andrew Kazdin, '63—he was a tympanist in the band—wrote four pieces for the band before transferring to the New England Conservatory of Music to study composition. After graduating there he came back to M.I.T. for a Master's degree in management, and now he produces classical recordings.

Works by Alumnus Stretch Band

John Bavicchi, '44, who studied management at M.I.T. before the band was formed (he's now on the faculty of the Berklee School of Music), is one of its most prolific composers; a Bavicchi piece is part of the repertory for every tour. Bavicchi's music is notoriously difficult to learn and appreciate: "He requires virtuoso playing," observes JoAnn Close, '81, three-year piccolo soloist with the band, "but his music does grow on you."

Craig Russell, '82, president of the band for 1983-84, composed and conducted a symphony for the band which was featured on the 1983 tour. The band has also played his "Fantasma," which he wrote in high school, and his "Killian Fanfare" was premiered at the 1983 Commencement.

Three band presidents—including Russell—have been honored by John Corley with invitations to be assistant conductor. The first, Barry Mirrer, '81, still plays with the band; the most recent, Charles Marge, '84, has directed about a third of the band's program. John Corley has great enthusiasm for his undergraduate conductors: "One of the great experiences of these last few years has been watching a student rehearse the band," John says. Members agree: "When Charlie conducts, I learn so much about the piece!" says Michael Good, '79, the principal trumpet.

"One of the greatest experiences has been watching a student rehearse the band."

The band is celebrating lots of anniversaries this year: the 100th of music at M.I.T., the 35th of the band and the 30th of its dedication to playing original concert works, the 10th of the membership of oboist Frank Kreimendahl, '77 (the band's most senior member), and the 25th of its annual tour.

The first tours in the early 1960s were performances at the Quebec Winter Carnival and the Festival of Contemporary American Music in New York City. Now the band travels for a week each year. In January, just before second term begins, the 65 musicians stash their instruments in a rented truck, climb into two buses, and escape from the shadow of the Institute for seven days, playing for alumni clubs, colleges, and high schools.

John Corley wants the tour to be "a good vacation experience as well as a good concert experience." And it is: for band members there is nothing more relaxing than being free to concentrate only on the music, working in that suspension of time that comes from playing in a different place each night and then moving on.

Students manage all aspects of this immense undertaking; a student manager, elected the spring before each tour, has the privilege of choosing the tour itinerary as well as the responsibility for all the arrangements.

This year's tour crossed into Canada, which meant we could call it "world tour." (Last year's went as far south as North Carolina, entitling us to call it the "Dixie Tour.") It was on this year's tour that Rodney Winter, director of the Ithaca College band, recollected for Corley his experience at Purdue: "My players were mostly young scientists and engineers, and they had a special vitality I've found nowhere else." John Corley, thinking of his own experience and of the 100-year history of music at M.I.T., knew what Wilson meant. □

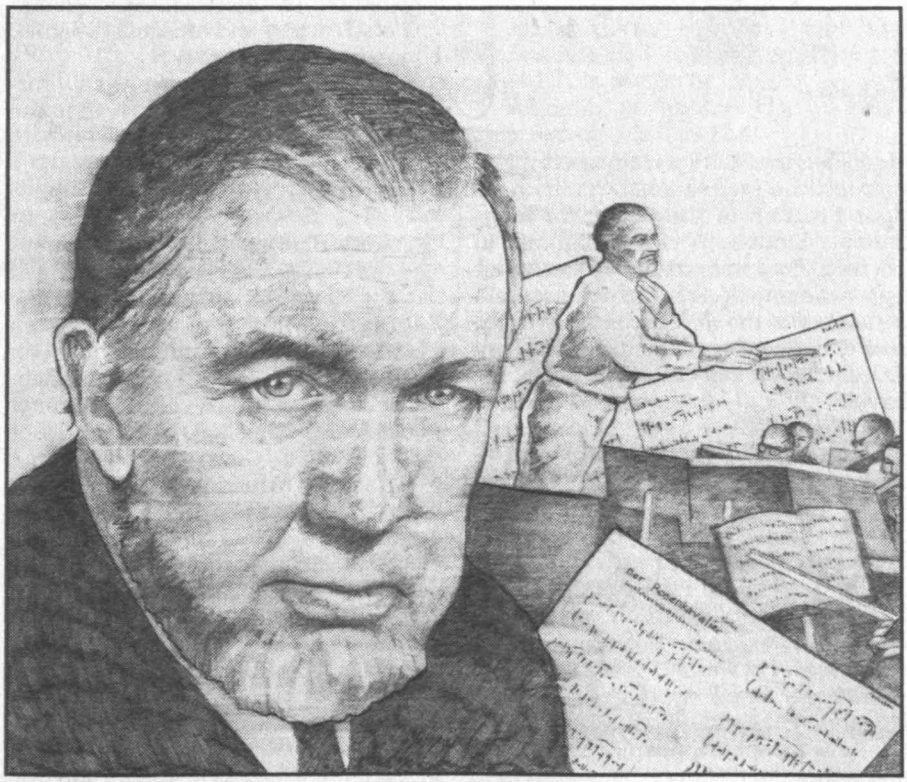


ILLUSTRATION: YAEL ZAKON-BOURKE

Obituaries

N. H. Frank

J. F. Thomson

Ithiel D. Pool, 1918-1984
Student of Communications and Their Social Effects

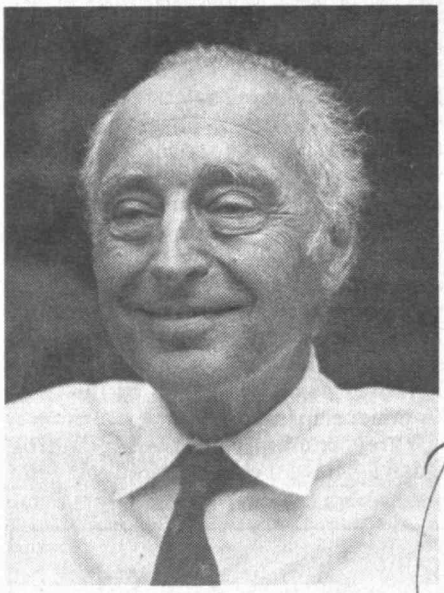
Ithiel de Sola Pool, professor of political science who was a leading student of the social effects of modern communications, died of cancer on March 11 at Mt. Auburn Hospital near his home in Cambridge. He was 66.

President Paul E. Gray, '54, paid tribute to Professor Pool as "an enormously effective teacher, researcher, and supportive colleague. He was the leading figure in the development of political science at M.I.T. and an inspiring force in its growth as a field of study at the Institute." Indeed, during the period when Pool was its head, the department was voted by one "rating" study the best graduate teaching department in the field in the country.

Professor Pool was also instrumental in founding and leading M.I.T.'s interdisciplinary research program on communications policy, and it was in this field that most of his research centered—the question of what is said, who listens, and who is heard.

In *Candidates, Issues, and Strategies* (1964) Professor Pool reported pioneering use of computer simulations of voting behavior during the John F. Kennedy presidential campaign. His article on "The Mass Media and Politics in the Modernization Process" (1963) inspired a generation of scholarship on development and communication, in which he was a principal participant. Even after his illness was diagnosed in 1980 Professor Pool published 20 articles and two books—*Forecasting the Telephone* and *Technologies of Freedom*, the latter on the important issues of free speech in an electronic age. And in *Communications Flows: A Census in the U.S. and Japan* (forthcoming from the University of Tokyo Press) Pool develops quantitative comparative indicators of "information overload."

Professor Pool's academic preparation was at the University of Chicago, from which his Ph.D. was awarded in 1952.



ADAM POOL

I. D. Pool

He joined the M.I.T. faculty a year later to direct the International Communications Program in the Center for International Studies. Widely recognized in his field, Pool was a fellow of the American Academy of Arts and Sciences and a member of the Defense Science Board and the Air Force Scientific Advisory Committee on Television and Social Behavior.

Nathaniel Frank, 1903-1984
Physicist Turned Educator

Nathaniel H. Frank, '23, professor emeritus of physics who was head of the Physics Department from 1952 to 1962, died on February 19 of a heart attack in his Brookline, Mass., apartment. He was 80.

Professor Frank specialized in theoretical physics and metallic conduction, but he is most remembered as a teacher and educational administrator, David S. Saxon, '41, chairman of the Corporation, recalled Professor Frank as "one of those rare teachers that have a profound and lasting effect on a career. . . . I had him for freshman physics," Saxon recalls, "and his influence was largely responsible for my becoming a physicist.

"He was a demanding but sympathetic teacher, a true mentor," said Dr. Saxon.

Frank entered M.I.T. in 1919 as a freshman, and 50 years later (1968) he retired from the Institute as professor of physics. Meanwhile he had earned two degrees (S.B. and Sc.D.—1927) in physics, served as assistant and instructor in physics and electrical engineering, and risen through the ranks of the faculty from his first appointment in 1930.

He was for one term vice-president of the American Association for the Advancement of Science and chairman of its Physics Section; he was an active member of the American Association of Physics Teachers and of Sigma Pi Sigma, honorary physics society.

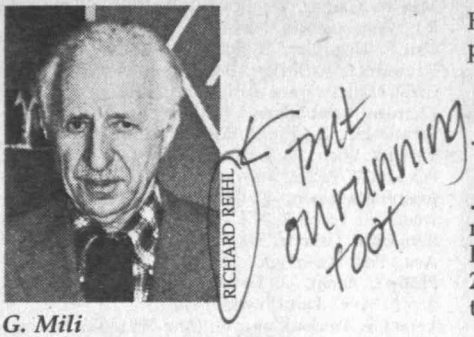
Frank was on leave from M.I.T. during World War II when he served in the Office of the Secretary of War.

Evers Burtner, 1894-1984

Evers Burtner, '15, who began his teaching career in the Department of Naval Architecture and Marine Engineering upon graduating from M.I.T. and served until retirement in 1958, died in a nursing home in Bradenton, Fla., on February 27; his summer home was in Kingston, N.H. Professor Burtner was 90.

A specialist in marine engineering and design, Professor Burtner was for several years in charge of subjects in this field. He was the author of the marine section of *Mark's Mechancial Engineers' Handbook* and the designer of a number of marine steam engines.

Burtner was also a yachting expert, beginning as yacht measurer in 1916 at the Eastern and Corinthian Yacht Clubs in Marblehead; he was also an honorary measurer at the Boston Yacht Club.



G. Mili

James Thomson, 1922-1984

Professor Emeritus James F. Thomson, who joined the M.I.T. Philosophy Department in 1963, was found dead of natural causes in his Boston home on February 15. He was 62.

Professor Thomson received his bachelor's degree from University College, London, after World War II service with the Royal Air Force; he held advanced degrees from Cambridge and Oxford, where he taught before coming to M.I.T. Professor Samuel J. Keyser, head of the department, credits Thomson with bringing many senior members of the present department to M.I.T. and in this and other ways "establishing the program's strength in analytic philosophy."

Harold C. Weber, 1896-1984

Harold C. Weber, '18, professor emeritus of chemical engineering, died on February 11 in Sun City, Ariz. He was 88.

After World War I service with the U.S. Army in chemical warfare and work in Boston as a consulting engineer, Professor Weber joined the M.I.T. faculty in 1922 to head the Boston Station of the Chemical Engineering Practice School. He became full professor in 1941, following a leave of absence for completion of his doctorate at the Eidgennosiche Technische Hochschule, Zurich, and retired in 1960. After World War II service, Professor Weber was for some years chief scientific adviser to the chief of research and development in the Chemical Warfare Service.

Guiseppe Colombo, 1921-84

Guiseppe Colombo, who was visiting professor at M.I.T. in 1981, died in Padua, Italy on February 20.

Colombo was professor of spacecraft and space structures at the University of Padua and professor of celestial mechanics at the Scuola Normale Superiore in Pisa; he was also associated with the Harvard-Smithsonian Center for Astrophysics for more than 20 years.

Keith T. Ennis, 1964-1984

Keith T. Ennis, '84, who would have received his undergraduate degree in chemical engineering next June, was found dead in his Tau Epsilon Phi fraternity room on February 29. It was ruled an accidental death due to inhalation of nitrous oxide.

Ennis was chancellor of Tau Epsilon Phi, a member of the Wu-Tang Chinese Martial Arts Club and the White Water Club, and a successful chemical engineering student, according to his fraternity associates.

Gjon Mili, 1905-1984

Gjon Mili, '27, distinguished professional photographer who pioneered the use of electronic flash after learning "strobe" techniques from his classmate Professor Harold E. Edgerton, died in a nursing home in Stamford, Conn., on February 14. He was 79.

Mili was a long-time contributor to *Life* Magazine and in recent years was a frequent visitor to M.I.T. for lectures and seminars. A decade ago he contributed a collection of photographs of M.I.T., many of them first made for *Life*, in a book entitled "M.I.T. Revisited."

John M. Fluke, Sr., 1912-1984

John M. Fluke, Sr., '36, a long-time Seattle civic leader and supporter of M.I.T. in the Pacific Northwest, died suddenly on February 11 at his home near Seattle. He was 72.

Mr. Fluke had recently stepped down as chief executive officer of the John Fluke Manufacturing Co., Inc., which he had founded 30 years earlier, but he continued as chairman of the board. He was a founding life member of the M.I.T. Sustaining Fellows, a member of the Corporation Development Committee, and served for three years starting in 1976 on the Visiting Committee to the Department of Electrical Engineering.

Deceased

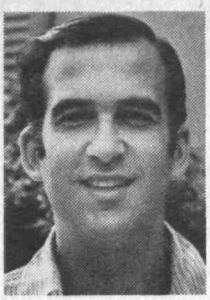
Leo Loeb, '08; January 30, 1984; 870 United Nations Plaza, New York, N.Y.
William E. Humphreville, Jr., '11; February 2, 1984; c/o G.R. Tees, 3108 Hector Dr., El Paso, Tex.
Rowland G. Wright, '12; May 6, 1978; c/o R.G. Riley, 404 Equitable Bldg., Des Moines, Iowa.
Victor J. Galleni, '14; November 4, 1983; 216 Pearl St., Newton, Mass.
Mrs. Paul S. Howes, '14; 1973; Apt. E1 Univ. Pk., Holyoke, Mass.
Wayne D. Bradley, '15; February 13, 1984; c/o Moosilauke Inn, Warren, N.H.
Evers Burtner, '15; February 27, 1984; PO Box 286A

Rt 1, Kingston, N.H.
Henry F. Daley, '15; January 9, 1984; 1790 Patricia Ave., Willow Grove, Penn.
Ellis S. Tisdale, '15; October 5, 1983; 18 Fisher Rd., c/o M. Ramsey, Hyannis, Mass.
Mrs. Thomas D. Brophy, '16; December 26, 1983; North Quaker Hill, Powling, N.Y.
Kenneth M. Sully, '16; April 1, 1983; 92-U Calle Aragon, Laguna Hills, Calif.
Elmer L. Joslin, '17; November 3, 1983; Deaconess Home, One Deaconess Rd., Concord, Mass.
Roberto Garza Sada, '18; 1982; Calzada St. Barbara 320, San Pedro Garza, Garcia, Mexico.
Harold C. Weber, '18; February 11, 1984; La Hacienda, 10333 West Olive, Apt. F179, Peoria, Ariz.
James H. Blodgett, '20; August 22, 1983; 2873 Bexley Pk. Rd., Columbus, Ohio.
Charles J. Lawson, '20; February 18, 1984; 114 Moorings Pk. Dr. No. A601, Naples, Fla.
Stanley C. Reynolds, '20; September 23, 1983; 200 East End Ave., New York, N.Y.
Howard M. Forbes, '21; October 19, 1983; 87 Church St., Weston, Mass.
Kenneth V. Hill, '21; June 14, 1980; Lake Chapin Rd., RT 2, Box 120-A, Berrien Springs, Mich.
George Schnitzler, '21; January 19, 1984; 8544 NW 12th St., Plantation, Fla.
Frances H. Clark, '22; December 19, 1983; 96 Rotary Dr., Summit, N.J.
Clarence I. Justheim, '22; July 3, 1983; PO Box 1981, Salt Lake City, Utah.
Dabney H. Maury, '22; May 19, 1983; 3648 Peachtree Rd. NE No. H2, Atlanta, Ga.
William H. Miller, '22; December 12, 1983; 5434 Floral Ave., Jacksonville, Fla.
Thomas P. Wynkoop, '22; September 15, 1983; 10500 Rockville Pike No. 1121, Rockville, Md.
Nathaniel H. Frank, '23; February 19, 1984; 101 Monmouth St., Brookline, Mass.
William R. Tayler, '23; June 26, 1974; Columbia University, 608 Philosophy, New York, N.Y.
John F. Wendt, '23; 1982; RT 9A, Lake Spafford, N.H.
Harold M. Wood, '23; August 9, 1983; 2200 Scottwood Ave., Toledo, Ohio.
Otto K. Eitel, '24; December 24, 1983; 10955 W Washington Blvd., Country V E, Culver City, Calif.
Irving Merkelson, '24; January 6, 1984; 112-13-39 Ave., Corona, N.Y.
Stacy B. Robeson, '24; September 2, 1983; 451-17 Mile Dr., Pacific Grove, Calif.
Lothrop H. Bailey, '25; April 9, 1983; 124 Idlewood Rd., Pittsburgh, Penn.
Harold H. Belcher, '25; January 30, 1984; 231 South Main St., Orange, Mass.
Henry G. Brousseau, '25; November 21, 1983; 42 Melvin Rd., c/o Mrs. John Sweet, Arlington, Mass.
Crispin C. Hall, '26; November 27, 1983; 589 Third Ave., Troy, N.Y.
Gregorio Y. Zara, '26; October 15, 1978; 352 Quezon Blvd., Quezon City, Philippines.
Royal Weller, '27; July 23, 1983; 417C NW 39th Rd., Gainesville, Fla.
Charles W. Hoyt, '28; January 24, 1984; 67 Crestview Rd., Belmont, Mass.
Robert J. Proctor, '28; February 3, 1984; 2752 Highlawn Ave., Huntington, W.V.
Rudolph J. Israel, '30; September 11, 1983; c/o Wallack, 4020 Oakhurst, Amarillo, Tex.
Walter J. Duffy, '32; May 19, 1983; 26 Birch Ln., Pelham, N.H.
Camilo Gutierrez, '32; June 1980; Carrera 6 No. 89-71 Piso 8, Bogota, Colombia.
Everett W. Harris, '32; September 7, 1983; 855 Vine St., Reno, Nev.
James Loughman, '33; February 4, 1984; RED 1, Box 278, Norridgewock, Maine.
Rafael Valdez, '33; January 18, 1978; c/o Ingenio Valdez, Milagro, Equador.
George W. Lindley, '34; January 4, 1984; 1880 Robin Way, Bethlehem, Penn.
John R. Newell, '34; February 13, 1984; 241 NE Spanish Trail, Boca Raton, Fla.
John D. Du Ross, Sr., '35; August 15, 1983; 1867 Wynwood Dr., Rocky River, Ohio.
John R. Vickery, Jr., '35; February 13, 1984; 17 Hibiscus Rd., Clearwater, Fla.
John M. Fluke, '36; February 10, 1984; 1206 NW Culbertson Dr., Seattle, Wash.
Max W. Garber, '36; October 21, 1983; 119 Payson Rd., Chestnut Hill, Mass.
Carl E. Megquier, '37; June 23, 1982.
Ravindra L. Kirloskar, '38; November 4, 1982; 17th Cross Malleswaram, Bangalore, India.
Charoen Pattabongse, '38; December 22, 1971; 189 Sarasin Ln., Raj Damri Rd., Bangkok, Thailand.
Tseng Y. Shen, '38; January 8, 1984; Lien Tung Ltd., PO 53-437, Taipei, Taiwan.
Joseph Blackman, '40; December 11, 1983; 526 Kenwood Pl., Teaneck, N.J.
Bernard F. Greene, '40; October 26, 1983; 8 Haven Ave., Port Washington, N.Y.
Philip C. Stein, '40; December 1, 1982; 135 S Lansdowne Ave., Lansdowne, Penn.
Yeram S. Touloukian, '41; June 1981; 233 Pawnee Dr., West Lafayette, Ind.
Theddeus F. Walkowicz, '41; October 7, 1983; 79 East 79th St., New York, N.Y.
Norman P. Pinto, '42; November 23, 1982; PO Box 253, Cambridge, Md.
Paul J. Fullerton, '43; September 1978; 3591 Jackson St., San Francisco, Calif.
Worthington S. Telford, Jr., '43; November 15, 1983; 3907 Bay Shore Rd., Sarasota, Fla.
Reynold F. Gamundi, '44; January 17, 1984; PO Box 27, c/o Benitez, St. Just, P.R.
Jules L. Lobsitz, '44; June 30, 1983; 705 Wall St., Vero Beach, Fla.
George M. Repetti, '44; September 25, 1982; 2 Thayer Rd., Colorado Springs, Col.
Alfredo Rodriguez Delfino, '44; February 5, 1977; Lea Mercedes-Calle Baruta, Ata Paramillo, Caracas, Venezuela.
Mualla I. Sezel, '44; January 19, 1983; Mithatpasa Cad 848/3, Goztepe, Izmir, Turkey.
Chandra S. Ghosh, '46; December 1968; 20B Hazra Rd., Calcutta, India.
Miltion E. Pugh, '47; April 15, 1982; 104 Saturn Ct., Indialantic, Fla.
Walter M. Vincent, '48; October 28, 1983; 568 Old Town Way, Hanover, Mass.
Allan Kriegel, '49; November 19, 1983; 320 Thornton Rd., Englewood, N.J.
James A. Stavrolakis, '49; October 20, 1983; 4656 West Touhy Ave., Chicago, Ill.
Jesus M. Bondoc, '50; February 29, 1980; 55 Twin Hills Mrhs, New Manila, Quezon City, Philippines.
James S. Hamlin, '50; April 8, 1981; 112 Harvest Rd., Cherry Hill, N.J.
Robert W. Dobbins, '51; November 12, 1983; 12 Mohawk Trail, Westfield, N.J.
Francis W. Small, Jr., '51; December 19, 1983; PO Box 716, East Greenwich, R.I.
Donald J. Terp, '51; December 5, 1983; 3405 Picwood Rd., Tampa, Fla.
Benjamin Zaxman, '51; January 8, 1984; 12512 S. Manor Dr., Hawthorne, Calif.
Louis M. Boisvert, '53; October 10, 1981; 1284 Bishop, Quebec, Canada.
Benjamin F. Juscen, '54; January 28, 1984; 1332 Vancouver Ave., Burlingame, Calif.
John A. Oerlich, '54; December 20, 1983; 189 Haynes St., Avon, Conn.
German A. Yia, '57; December 28, 1971; 972 May St., Mandaluyong, Rizal, Philippines.
Robert D. Smith, '59; February 6, 1977; 92 Fiesta Way, Fort Lauderdale, Fla.
David Walter Rumsey, '62; October 1983; 47 Rue De Lyon, Paris, France.
John W. Darrin, '63; February 3, 1984; 480 Franklin St., Reading, Mass.
John H. Goodloe, '64; September 10, 1982; 602 Flemington Rd. SE, Huntsville, Ala.
Mark C. Horvath, '66; September 12, 1982; 809 Salem Dr., Huron, Ohio.
Carl A. Julien, '67; January 25, 1976; 2512 Fulton Ave., Davenport, Iowa.
Donald H. Evans, '73; January 20, 1984; 2079 Delaware, Ann Arbor, Mich.
James R. Early, '74; October 11, 1983; 815 Great Springs Rd., Rosemont, Penn.
Delbert W. Rice, '75; c/o Communications Research Center, Shirley Bay Box 490, Station A, Ottawa, Canada.

How Old Are Euclid's Children?

Larger?

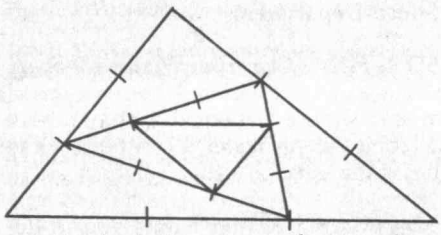
Puzzle Corner/Allan Gottlieb



Allan J. Gottlieb, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

Daniel Shapiro's article in the February *American Mathematical Monthly* contains a result that I think you will find interesting.

It is easy to see that if the midpoints of the three sides of a triangle are connected, the resulting triangle is similar to the original one. If you use trisection

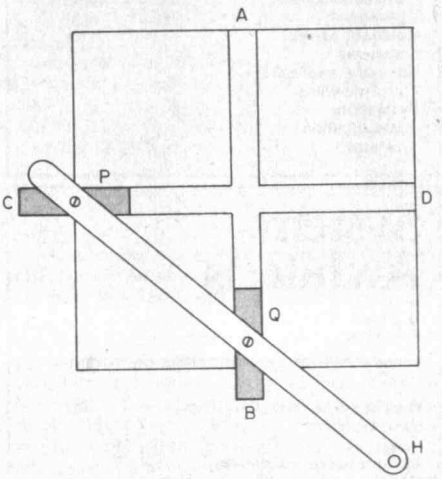


points, similarity occurs after two iterations, i.e., the smallest triangle in the figure above is similar to the largest. A natural question to ask is what happens for ratios like 1/5, 2/7, or other rationals? Shapiro shows (among other things) that 1/2 and 1/3 are special; for all other rationals the triangles determined by successive iterations are all dissimilar (unless the original triangle is regular or degenerate). I was surprised; are you?

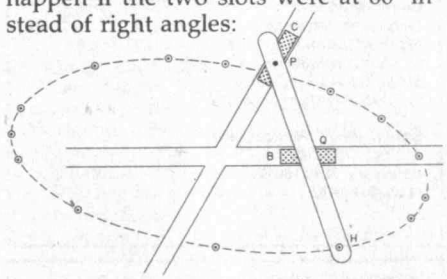
Problems

M/J 1. We begin with a chess problem from John Walz, who adds that until recently he believed that no solution was possible:
Given all 32 pieces, place them on the board in such a way that neither player can move or capture a piece. Pawns can be on any rank and doubled, tripled, even quadrupled upon the same file. No piece can be considered a promoted pawn (use of three bishops and only seven pawns is illegal).

M/J 2. Phelps Meaker enjoyed **1983 JUL 4** and now proposes a variant. The original problem called for the analysis of the device shown at the top of the next column, proving that the orbit of H is an ellipse as H is rotated a full 360° with travellers B and C moving in their respective slots.
Now Mr. Meaker writes:



After the fun with the trammel of JUL 4 (1983), I began to wonder what would happen if the two slots were at 60° instead of right angles:



The figure seems to be an ellipse. I drew an ellipse with axes of the same length with two pins and a string, and they seem to coincide. Prove whether it is a true ellipse. Can the tilt of the major axis be calculated?

M/J 3. Reino Hakala wants you to find the Maclaurin series for sin and cos *without* using calculus or higher mathematics, although the concept of limits may be used. By way of an analogy, $(1 + x/n)^n$ can be expanded using the binomial theorem for n a positive integer (hence derivable without calculus) to give, after simplifying
$1 + x + (1 - 1/n)\, x^2/2! + (1 - 1/n)(1 - 2/n)\, x^3/3! + \ldots,$
which, upon letting x approach infinity, becomes the Maclaurin series for e^x.

M/J 4. Anthony Beris recalls a problem

he encountered at a math Olympiad: Consider the number $8888^{8888} \equiv A$. Suppose you were able to write it in decimal form. Then suppose you add its decimal digits together and therefore construct their sum $\equiv B$. Again, write B in decimal form and add its decimal digits to form a new number C. Repeat this step once more (add the decimal digits of C to form a new number). What is this last number?

M/J 5. Our final regular problem is from John Hughes:
"None of my children is over twenty," said Mr. Euclid, "and I notice that this year the sum of the cubes of the ages in years of the younger three is equal to the cube of the age of the eldest." "I can't tell their ages from that information," said his friend Mr. Diophant, "even though I know the age of the eldest of your four kids." What was the age of Mr. Euclid's third child?

Speed Department

SD 1. Here's one from Phelps Meaker: An open-top cubical tank has an internal area in square feet equal to the number of cubic feet of water it can hold. How big is the tank?

SD 2. Steven Kanter wants you to determine the hands and the grand slam bid so that no matter who the declarer is, the defenders get all of the tricks!

Solutions

JAN 1. South is declarer at the contract of four spades:

	♠ J 9 8 5 2 ♥ A ♦ – ♣ A K Q 10 9 6 4	
♠ A Q 3 ♥ K J 3 ♦ A J 10 8 6 ♣ J 2		♠ K 7 ♥ 9 6 5 4 2 ♦ K Q ♣ 5 3
	♠ 10 6 4 ♥ Q 10 8 7 ♦ 5 4 3 2 ♣ 8 7	

West leads the ♦A. Would you choose to be declarer or defender?

Smith D. Turner (Jdt) gave the missing ♦7 and ♦9 to East, notes that Ruth Turner wonders what contorted bidding system could result in a spade contract, and writes:
The defense can be held to the three top trump tricks. Defense is on the right track in opening and continuing diamonds to reduce North's trumps and reentries, but this line will not reach far enough. The most difficult defense I found to overcome is:

	West	North	East	South
1.	♦A	♠2	♦7	♥2
2.	♠A	♠5	♠7	♠10
3.	♦6	♠8	♦9	♦3
4.	♠3	♠9	♠K	♠4
5.	♦J		♦K	♦4
6.	♣2	♠J ♣A	♣J	♣7
7.	♣J	♣K	♣3	♣8
8.		♣Q	♥2	♦5

If West does not trump at trick 8, North continues clubs until West does trump. After trumping, if West leads a heart the board is good; if West leads a diamond, South trumps, leads a heart, and the board is good. It does not help the defense to knock out this last heart reentry by leading a heart on, say, trick 3, as this saves North from using a spade for reentry.

Also solved by Alan Robock, Matthew Fountain, Peter Silverberg, Robert Bart, Warren Mathews, Winslow Hartford, Richard Hess, and the proposer, Doug Van Patter.

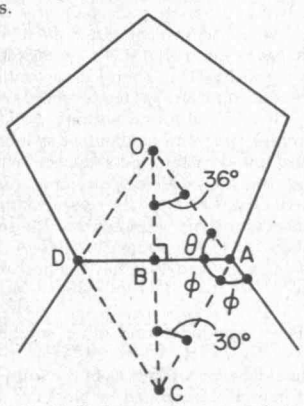
JAN 2. It is found that 91.3 percent of *Technology Review* readers enjoy "Puzzle Corner," a value accurate to three digits. What is the minimum number of readers the reporter could have polled for this value to be so accurate?

Robert Bart, unlike the editor, prefers to consider respondents who dislike "Puzzle Corner." If .913 enjoyed "Puzzle Corner," .087 did not. N being the number of respondents, and since responses are assumed to be integers, .087N = i where .087 is correct to three places. For i = 1, N cannot be an integer but for i = 2, N = 23 is very close to 2/.087. This is therefore the smallest survey sample with 21 of 23 favorable responses producing the result.

Also solved by Winslow Hartford, Steven Feldman, Robert Bart, Peter Silverberg, Phelps Meaker, Frank Carbin, David Gluss, Matthew Fountain, John Prussing, Harry Zaremba, R. Raines, Richard Hess, Avi Ornstein, and the proposer, Greg Huber.

JAN 3. The soccer ball in current use appears to be made from 32 pieces of leather, 12 black pieces in the shape of regular pentagons and 20 white pieces in the shape of regular hexagons. Instead of forming a polyhedron, air pressure pushes the sides out into a circumscribing sphere. How many vertices does the basic polyhedron have? Do all of these vertices lie on the circumscribing sphere? If the edge of each pentagon and each hexagon is exactly 2 inches in length, calculate the diameter of the circumscribing sphere.

The following solution is from Harry Zaremba:
The polyhedron that contains the given number of regular polygons is the truncated icosahedron. Its surface is composed of 12 identical patterns each of which consists of a regular pentagon encircled by five hexagons. The polyhedron has 60 vertices and 90 edges.



To obtain the ball diameter, assume that after inflation of the ball each edge of the polygons lies on a great circle and that its arc length equals 2 inches. In the figure shown, points C and O are on the sphere's surface and are equidistant from their polygon's vertices. Since the angles between the great circles passing though point O and the pentagon's vertices are equal, we have angle BOA equal to 360/(2 × 5) = 36°. Similarly, at point C of the adjacent hexagon, angle BCA equals 360/(2 × 6) = 30°. Let β be the angle subtended by arc length AB at the ball's center, and let R equal the radius of the ball. Since AB = 1", we have,

$R = 1/\beta$ (1)

From spherical triangles BOA and BCA,

$\cos 36° = \cos \beta \sin \theta$ (2)

$\cos 30° = \cos \beta \sin \phi$ (3)

and from vertex A,

$\theta = 180° - 2\phi$ (4)

The solution of equations (2),(3), and (4) yields $\theta = 55.69064°$, $\phi = 62.15468°$; and $\beta = 11.64072° = 0.20317$ radians.

Thus, from equation (1), R = 1/0.20317 = 4.922". Hence, the ball diameter is $D = 2R = 9.844$ *inches*.

The spherical excess in triangle DOA is

$E_p = 72° + 2\theta - 180° = 2\theta - 108°$

and the spherical excess in triangle DCA is

$E_h = 60° + 2\phi - 180° = 2\phi - 120°$.

The area of all pentagons will be

$A_p = 12 \times 5 \times \pi R^2/180 \times E_p = \pi R^2/3 \times (2\theta - 108)$ (5)

and the area of all hexagons will be

$A_h = 20 \times 6 \times \pi R^2/180 \times E_h = 2\pi R^2/3 \times (2\phi - 120)$. (6)

Substitution of equation (4) into (5), and addition of equations (5) and (6), yields

$A = A_p + A_h = 4\pi R^2$.

This is the surface area of a sphere which verifies that the vertices of the ball lie on the sphere's surface.

Also solved by Matthew Fountain, Winslow Hartford, Norman Wickstrand, Richard Hess, and the proposer, Winthrop Leeds.

JAN 4. On the planet Trayshowed in a distant galaxy, an earth scientist was asked to measure the blackbody temperature of the sun. Their day/night cycle was 36 hours, so the scientist was somewhat frazzled; however, he was spared a little work when he noticed that without moving his apparatus sunlight would enter it for a full 6 minutes. As predicted, the blackbody equivalent temperature was found to be 5500 Kelvin. What kind of clothing did our scientist wear?

Yes, Trayshowed is tres chaud! Alan Robock writes:
The scientist probably wore regular clothes, as he would have to be inside a spaceship to survive the high temperatures. He could possibly be wearing a space suit, probably with a French cut. In order to calculate the surface temperture, I first note that sunlight would enter the apparatus for 6 minutes of a 36-hour day. This is 6/(36 × 60) = 1/360 of a day, implying that the diameter of the sun subtends 1° from the planet.

If r = radius of the sun, and R is the distance from the center of the sun to the center of the planet, we can set up an approximately right triangle in the diagram below such that sin 1° = (2r)/R. If s = heat flux at the surface of the sun and S = heat flux from the sun at the mean sun-planet distance (the so-called "solar constant"), then from the inverse square for radiation,

$S = r^2 s/R^2 = [r^2(\sin 1°)^2 s]/4r^2$.

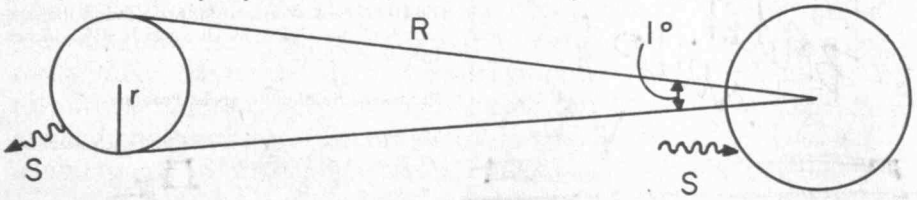
From the Stefan-Bolzmann law, we know that $s = \sigma T^4$, and T = 5500 K. We can set up an energy balance equation for the planet:

$S(1 - \alpha)/4 = \sigma T_p^4$,

where T_p is the planetary temperature, α is the albedo (reflectivity), and the S/4 factor comes from the 1:4 ratio of the area of the circle intersected by the sun's rays to the surface area of the planet. Substituting the above equations for S and s into the energy balance equation, we find that

$T_p = [(\sin 1°)^2(1 - \alpha)/16]^{1/4} T$.

The resulting surface temperature (T_s) then depends



on the assumptions made about the planetary albedo (α) and about the atmosphere of the planet. For the earth, $\alpha = 0.30$, and the effective radiative temperature of the planet (T_p) = 254 K = −19°C. Because the earth has an atmosphere, and some of the gases are transparent to solar radiation but absorb and re-emit in the long-wave, the so-called "greenhouse effect" is created. As a result, the average surface temperature of earth is 288 K = 15°C. For the planet in question, if there is no atmosphere (in which case $T_p = T_s$, and the above answer about the scientist's dress applies independent of temperature) and the planet is black ($\alpha = 0$), T_p = 363 K. If $\alpha = 0.5$, T_p = 305.5 K, still quite hot. If α = 0.3, as on earth, T_p = 332 K. With an atmosphere like earth's, the greenhouse effect would increase T_s to about 370 K, too hot to not be protected.

Also solved by Winslow Hartford, David Gluss, Matthew Fountain, Richard Hess, and the proposer, Dan Dewey.

Better Late Than Never

Through an error in New York compounded in Cambridge we failed in the last issue to credit Richard Hess with solutions to **N/D1, N/D2, N/D3,** and **N/D4,** and Edward Dawson with a solution to **N/D4.**

1981 OCT 3. Walter Nissen, Jr., notes that the 88-digit number consisting of the concatenation of the smallest solution to itself is also a solution, as are higher "multiples."

Y1983 Harry (Hap) Hazard notes that we need a minus sign for 56 and submits the following improvements. Have a *healthy* 1984, Dr. Hazard.

$1^{98} \times 3$
$1^{98} + 3$
$(19 + 8) \div 3$
$(91 - 3) \div 8$
$(81/3) - 9$
$1^9 + (8 \times 3)$
$(19 - 8) \times 3$
$1 \times (9 + 8) \times 3$
$1 + [(9 + 8) \times 3]$
$81 - (9 \times 3)$
$(9 - 3 + 1) \times 8$
$1 + (9 \times 8) - 3$
$(19 + 8) \times 3$
$1^9 \times 83$
$1^9 + 83$

1983 M/J 4. William Veeck found an alternative solution.

JUL 5. Donald Savage has looked a little further and reports the following:
Nob Yoshigahara's problem led to something unexpected, as perhaps he knew. I anticipated that the next two appropriate perfect squares were not "nearby," so I had my computer do it. In short order, it came up with $(3114)^2 = 9696996$, and $(81619)^2 = 66616661161$. Then I let it continue the hunt for more numbers. After several days it had gone by 2.8×10^7 and found nothing. So I wrote a faster-running program. In about a day it had gone by 10^{11} and found nothing! So I suspect there aren't any more; but how does one prove it? (Someone should ask Gerd Faltings.) By way of clarification, my (homemade) computer looked at the square of all numbers up to the square of $(10^{11}+)$. So how about asking your readers if they can find any more solutions?

A/S 5. Brian Almond found other solutions and writes:
The general form of X is blocks of the form 219 . . . 978 (0 or more 9's) separated by blocks of the form 0 . . . 0. X must begin and end in a block of the first form. Also, the numbers of 9's and 0's in the blocks are symmetric with respect to the center block in X. There may be an odd or an even number of blocks of the first form. For example, see the form shown across the top of this page.

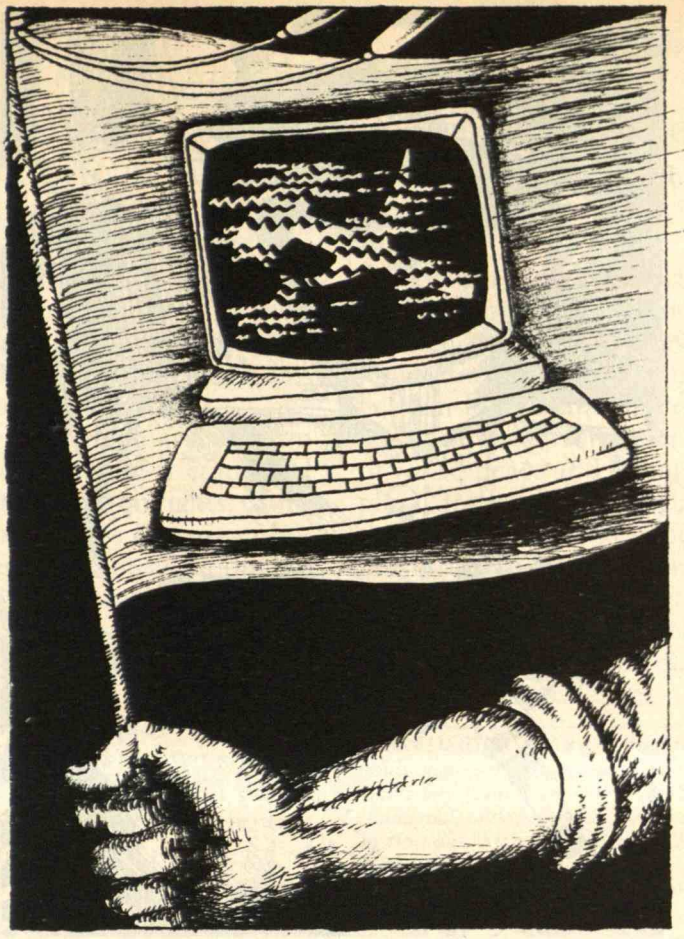
OCT SD2. Lionel Bauduy found a six-step solution.

1984 JAN SD1. Warren Matthews found that the length of the walk is much closer to 959.5 inches than to 959.75 inches.

Proposer's Solution to Speed Problem

M/J SD2. The contract is 7NT and each hand has all 13 cards in a single suit.

indication of end



conflict, which makes itself felt in virtually every Soviet family today.

Soviet families have been altered almost beyond recognition. Differences in education between fathers and children erode the authority of the traditional *pater familias*. Ripped from their rural environment and thrown into impersonal apartment blocks, individual family members are less subject to collective controls, whether from other members of their families or from society at large. The rise of urban crime is an accurate barometer of the breakdown of the traditional collective discipline.

With less ready recourse to control by the collective group, individuals are more likely than ever before to use impersonal legal processes to adjudicate conflicts. The recourse to objective legal norms as opposed to dictates of the village collective is itself an important expansion of the individual's realm of freedom.

Nor do the cliches of collectivist ideology provide strong values upon which individual Soviet citizens can base their actions. The widespread search for new principles finds expression in many forms, among them being the shift in student interest from the natural sciences to the humanities. Surveys of Soviet high-school graduates reveal the rapid rise in prestige of the profession of writer. Such shifts suggest that the clarification of values has become a personal rather than a social function.

The breakdown of old value systems has led some Soviet young people to take refuge in a naive "redneck patriotism." Still larger numbers of Soviet youths find their psychological home in an emerging popular culture guided overwhelmingly by creative individuals whose lives are little subject to state control. Today, the basic values of Soviet popular culture are far more strongly influenced by independent-minded and youthful Soviet trend-setters, or by their counterparts in the United States, England, and France, than by any official Soviet organs.

Prospects for the Future

The best evidence of the growth of a freer mentality in the Soviet Union is the way the rising generation exploits minor technologies for its own private ends. The government's former monopoly of information is far from total today. Where once there were cable radios tuned to the one official station, there are now millions of privately owned short wave receivers. Small, readily available tape recorders render permanent and transmittable the ephemera of independent speech and song. Even the state's monopoly of photocopying machines has been weakened, as the adventurous make use of the proliferating copy machines in their offices and institutes. Without denying the severity of the many controls that still exist, one can only be struck by the multiplying of private modes of communication, thanks to new technologies.

To be sure, the Soviet state maintains its former instruments of control. It is even enhancing them, as the KGB and other security agencies acquire their own advanced computer systems. Nonetheless, state agencies are gradually finding it more difficult to exercise the full measure of control over the lives of individual citizens that they are empowered to exert by Soviet law.

In the face of well-publicized instances of clear Soviet violations of human rights, this claim may seem dubious, if not false. Nonetheless, three separate considerations give grounds for thinking that self-restraint by the Soviet state in the treatment of its own population will increase rather than decrease in the coming years.

First, the emerging forms of settlement and employment are far harder to police than those of earlier Russia. In the old days, local party representatives easily monitored the populations of rural vil-

lages. Today, urban dwellers live an average of an hour and thirty minutes from their places of work and must therefore spend a large part of each day moving about on their own, beyond the reach of authorities. As they free themselves from age-old habits of subordination to the collective, these people gain experience in making decisions about their lives and in maximizing their own advantage in a complex world. The number of people in this unfamiliar situation has become so great that it is beyond the power even of the huge Soviet security apparatus to keep track of every individual's actions.

Second, methods of public control in the Soviet Union must be responsive to the urgent need to motivate skilled persons to work. Neither simple exhortation nor the threat of force serves this end today. While one might argue that the productivity of Soviet workers will not increase until basic administrative reforms are introduced, the prevailing lock-step regimentation is obviously counterproductive. As demand for higher productivity grows ever more urgent, the need to accommodate the desires of the urban populace will become unavoidable.

Third, if the Soviet government is to exert strict controls over the population it must have resolute organizations and individuals to carry out its policies. In the past, this task has fallen to the Communist party and the KGB. The effectiveness of both bodies has been based on their status as quasi-military organizations whose esprit de corps and self-discipline sharply distinguish their members from the population at large. Today, both groups, especially the party, are beset by erosive tendencies.

The Soviet Communist party is usually conceived of as a small and highly disciplined elite. It is indeed small, comprising scarcely 5 percent of the population. It is also an elite that places severe and constant demands upon its members, particularly those who serve as professionals on its staff. At the same time, party membership has been virtually a requirement for the highly educated. Fully two-thirds of college-educated urban males of working age hold party cards.

Recent developments present the party with a dilemma. Urbanization and technological advances have been accompanied by a vast increase in higher education. If the party is to maintain its presence among the educated classes, it must increase its membership proportionate to the growth of college graduates. Yet if the party pursues this course, it will become a sprawling and loose organization, incapable of exerting control over society as a disciplined elite.

The KGB, too, functions in an environment very different from that which existed only a generation ago. It was easy to control a small educated class whose members rarely went abroad. The growing number and sophistication of the technological elite is changing this situation. The rising second-generation intellectuals are more self-confident, more venturesome intellectually, and less tolerant of primitive controls. Nor can members of the burgeoning intellectual class be excluded from privileged information. The very complexity of the economy, and the first steps toward an information society, require that millions of persons be entrusted with what formerly was considered sensitive or even secret information. Finally, if the economy is to advance, members of the elite must be motivated to work. For this to happen, they must be granted a degree of freedom.

Good-Bye to Brave New World?

These social changes are the direct result of the introduction of advanced technology into Soviet life. Such factors give grounds for thinking that the sphere of individual freedom in the Soviet Union

The first steps toward an information society require that millions of persons be entrusted with information considered sensitive or even secret.

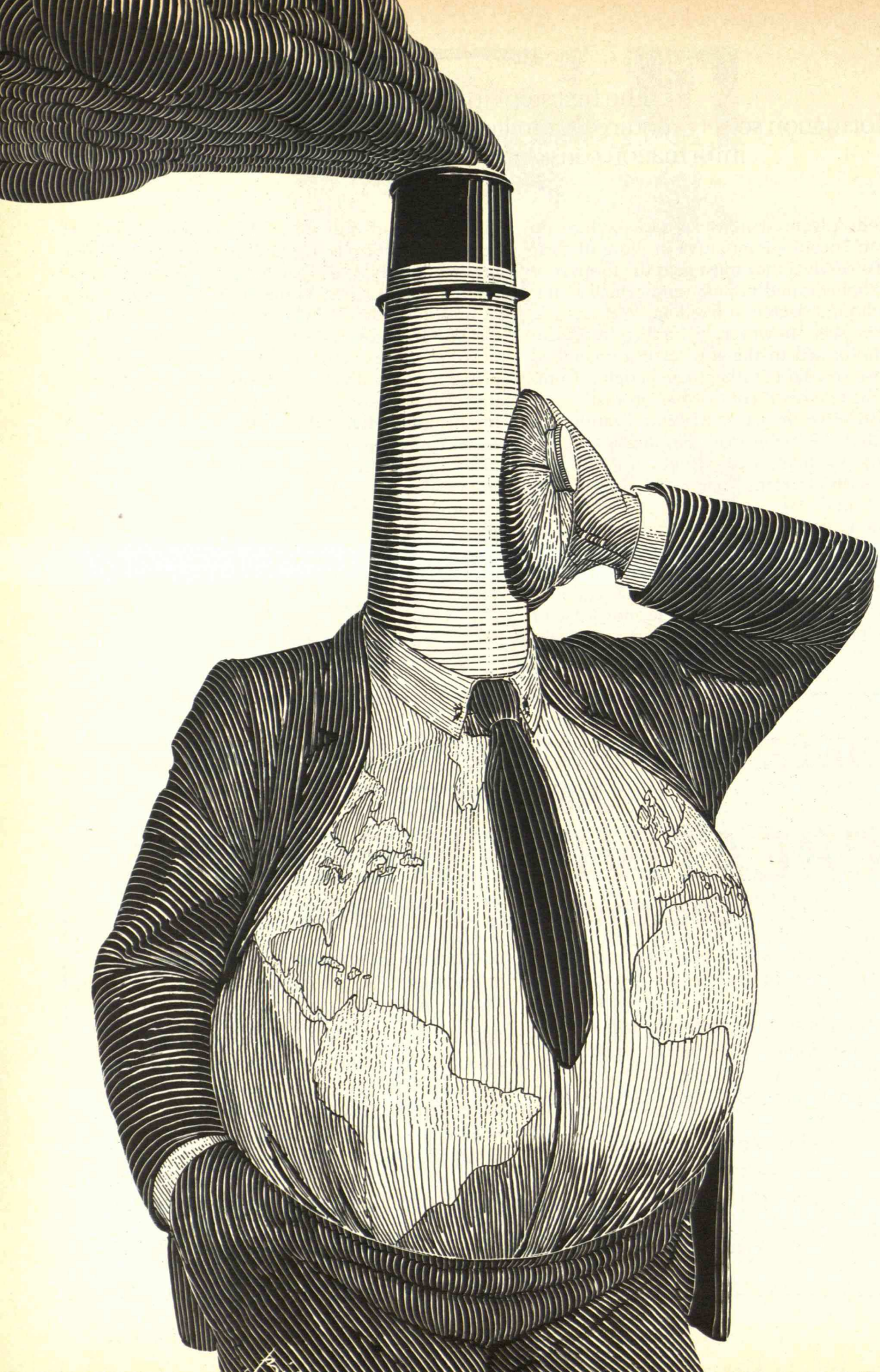
might expand. Advanced industrial societies have no choice but to encourage initiative in more of their members. To survive, they must gain the support of ever more sophisticated populations, which is impossible without a degree of freedom.

As we have seen, however, technology itself can readily be harnessed to the service of a command economy based on duties rather than on rights. Computers can make central control less obtrusive, but they can also serve the cause of centralization. To the extent that they reinforce centralization in the Soviet Union, one might expect that tensions might arise between the emerging society and the economy that supports it.

Such tensions are by no means unique to the Soviet Union; they are already evident in our own society. The way they are resolved in the USSR will define the degree of freedom that prevails in that country. Many forces will affect the outcome, not least of them being the international environment. If conditions abroad fan official Soviet insecurities, the government will have grounds for repressing the natural tendencies of the new society. A more tranquil international order will undermine the major justification for maintaining old-fashioned controls.

The Soviet government has declared itself in favor of world peace and unimpeded contacts among peoples. Paradoxically, these are precisely the conditions that will do most to undermine the vestiges of Stalinism and to set free the natural tendencies of Soviet social evolution. International tranquility and contact across borders, rather than high technology per se, will determine the balance between the forces of continuity and change.

S. FREDERICK STARR is president of Oberlin College in Ohio. He holds degrees in history and Slavonic languages and literature from Yale University, Cambridge University, and Princeton University. *This article is adapted, with permission, from a paper delivered at the Smithsonian Institution's Eighth International Symposium, "The Road After 1984: High Technology and Human Freedom." The paper will be published in a future volume of essays by Smithsonian Press.*



Policymakers concerned with the warming of earth's atmosphere by carbon dioxide have faced a choice between inaction and rapid change. However, a new study suggests an international strategy that does not require major alterations in energy use.

Reducing the Problem of Global Warming

BY DAVID J. ROSE, MARVIN M. MILLER, AND CARSON AGNEW

Some years ago, Herman Kahn posed the following question: Suppose you discover that, assuredly, a certain event will occur a decade or two hence. It will not affect you or your own descendants, but 200 years from now, everyone will surely die from its consequences. How much would you be willing to do, today, to prevent it?

The global greenhouse effect—the warming of earth's atmosphere by the large amounts of carbon dioxide (CO_2) injected into it when fossil fuels burn—does not present quite so foreboding an outcome as Kahn's imaginary dilemma. Nevetheless, it carries many of the same overtones for policymakers. If excess CO_2 is indeed heating the atmosphere, it could ultimately alter the whole pattern of human life on the planet. Yet if we intervene to prevent such a possibility, we might have to change our present mode of living drastically. Making the problem extremely tough is the fact no conclusive evidence has yet emerged that excess carbon dioxide is actually warming our climate.

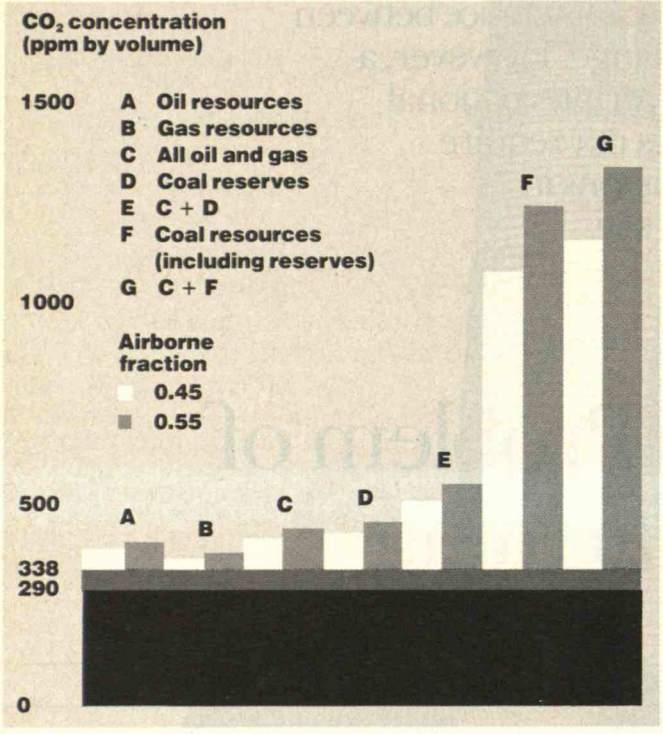
Nevertheless, the possibility that a drastic warming is under way is serious enough to have persuaded many scientists to call for immediate action to reduce the hazard to future generations, by severely restricting the use of coal and other fossil fuels. More cautious analysts counter that policymakers should understand the magnitude of the problem more fully before they take action.

We believe that we have identified a middle way between those extremes. A study that we recently carried out for the National Science Foundation indicates that nations can limit the increase in atmospheric temperature from excess CO_2, primarily by increasing the efficiency with which they use energy. What is needed, our study suggests, is international cooperation—soon—to adopt CO_2-benign energy policies. These would be designed to maintain the input of carbon dioxide into the atmosphere at no more than its present level of about 5 billion tons per year. In this situation, the atmospheric concentration of CO_2 would rise from its present value of 338 parts per million (ppm) to no more than about 420 ppm by the year 2050.

Most scientists accept the idea that doubling the pre-1900 level of 300 ppm of carbon dioxide in the atmosphere would cause catastrophic warming of the earth. The energy policies suggested by our model would give the atmosphere a breathing space of several centuries before it reaches that doubled

ILLUSTRATIONS: CHRISTOPHER BING

Coal will be the dominant contributor to the buildup of carbon dioxide in the atmosphere beyond today's level of 338 ppm. Combustion of all known recoverable oil and gas will not raise CO_2 concentration above 450 ppm (A, B and C). But burning any significant fraction of the world's 5 trillion tons of recoverable coal resources will push CO_2 above 600 ppm (F)—more than double the preindustrial concentration of 290 ppm. Values for airborne fraction refer to CO_2 that stays in the atmosphere.



level. This scenario contrasts with the common estimates that atmospheric CO_2 will double in less than 100 years (*see box, page 58*).

Causes and Effects of the Warming

Scientists have been aware of the greenhouse effect since 1896. Swedish chemist Svante Arrhenius first advanced the hypothesis that an increase in the atmospheric concentration of CO_2 would raise the earth's surface temperature and lead to changes in other aspects of climate, such as rainfall and patterns of soil moisture. Since then, many scientists have refined our understanding of the way the warming mechanism works. The greenhouse effect stems from the different reactions of atmospheric carbon dioxide with different forms of radiant energy. The CO_2 gas is transparent to the visible light that enters the atmosphere from the sun. But the gas absorbs, and then reradiates in all directions, some of the infrared energy that the surface of the earth emits outward toward space. As a result, the equilibrium between energy entering the atmosphere from the sun and leaving it from the earth is established at a higher temperature than would be the case if the atmosphere contained no CO_2.

As the proportion of carbon dioxide in the atmosphere increases, the average temperature of the atmosphere rises with it. The best current models of the climate predict that a doubling of CO_2 from pre-1900 levels to 600 ppm would produce an average increase in temperature of about 3°C over the whole globe, with an estimated uncertainty of plus or minus 1.5°C. That average disguises considerable variation with location. A smaller temperature increase in the tropics would be balanced by increases of two to three times as much at high latitudes. In the Northern Hemisphere's temperate zone, for example, which includes much of the United States and Europe, the temperature would rise by between 4° and 6°C.

Atmospheric carbon dioxide does not stem from fossil fuels alone. Recent analyses by George M. Woodwell and his associates at the Woods Hole Marine Biological Laboratory show that global deforestation has contributed significantly to the increase in CO_2 during the last hundred years. If deforestation continues to increase with population, Woodwell's research shows, that contribution to the CO_2 buildup will also grow, until forests are exhausted early in the next century.

In addition, other "greenhouse gases" contribute to global warming. Some of them, such as carbon monoxide and nitric oxide, also result from the combustion of fossil fuels. Others, including nitrous oxide and the chlorofluoromethanes, come from other sources. Their collective impact is difficult to quantify, but recent analyses show that they could raise the temperature by half as much again as any increase caused by CO_2 alone.

Even with the contributions of all the other greenhouse gases, the temperature increases expected from a doubling of CO_2 seem relatively modest. But climatologists who have studied fossils and isotopes from the "altithermal" era 10,000 years ago—the last period when the earth was appreciably hotter than it is today—warn that the warming could cause major changes in weather and agricultural patterns.

Some effects of an atmospheric warming are catastrophic. The possible melting of the West Antarctic ice sheet, for example, could lead to an increase in sea level that would flood many lowlands throughout the world, as well as major port cities. Other effects are more ambiguous; certain regions and countries could emerge as "winners" while other would end up as "losers." For example, large parts of Africa, the Middle East, India, and China might

DIAGRAMS: OMNIGRAPHICS

become wetter as a result of global warming, and thus more hospitable to agriculture. However, much of the western two-thirds of the United States and large parts of the Soviet Union would probably end up hotter and drier than today, making it harder to grow wheat, corn, and other major food crops. Even in "winning" areas, human populations and ecosystems will need substantial time to adjust to climatic changes. Add the large uncertainties in our knowledge of climatic impacts, and it seems foolhardy to tinker with the earth's climate. This is especially true if a warming can be avoided or ameliorated by actions that make sense quite apart from their effect on CO_2 buildup.

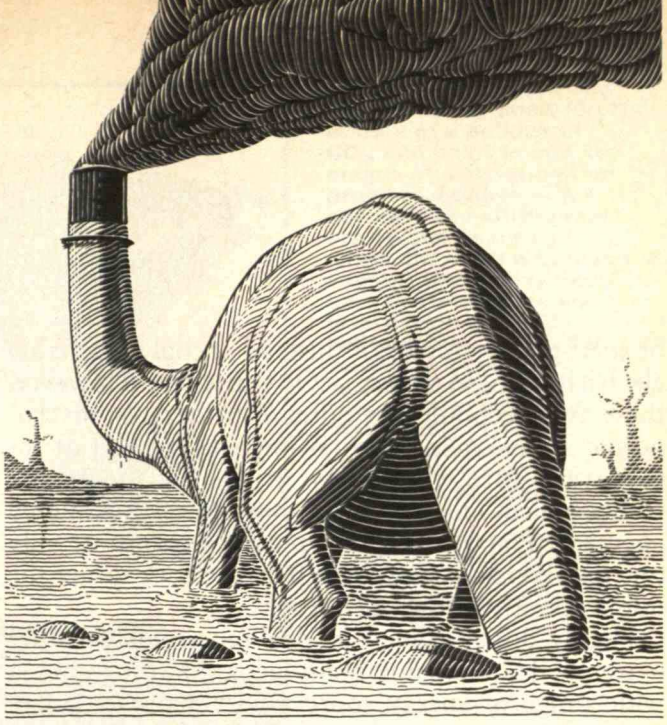
Three broad measures have actually been taken or proposed to deal with the CO_2 threat:

☐ Carry out more research to improve our ability to predict the magnitude and timing of temperature changes associated with given levels of CO_2.

☐ Develop and carry out methods of adapting to climate change, such as new crop species that can thrive in hotter, drier climates and systems of dikes to prevent lowlands from flooding.

☐ Adopt global energy strategies to reduce the burning of fossil fuels.

So far, scientists have devoted much effort to the first alternative; the others have been the subject of much discussion but little action. The reasons for this, particularly in respect to new energy strategies, are clear. CO_2-benign energy strategies include more efficent use of energy, a transition away from fossil fuels—particularly coal—toward nuclear and renewable resources, a concomitant trend toward greater reliance on electric energy, a slowdown in population growth, and greater use of recycled and longer-lasting materials. But influential members of the technology and public-policy communities argue that forceful action on any or all of these would be premature at best. For example, many share the view of the late Carroll Wilson of M.I.T. that the earth's vast resources of coal form a logical and necessary bridge to the future. Other observers see little potential for greatly decreasing energy consumption by more efficient use.



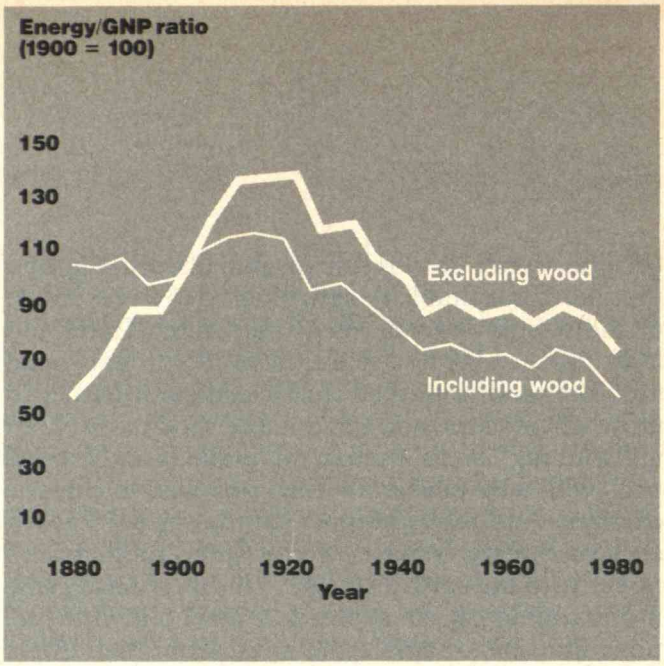
Many share the view that the earth's vast resources of coal form a logical and necessary bridge to the future.

Energy Models and Modeling

Do those doubts make sense? Since the Western world's first energy shock in 1973, energy specialists have devoted much effort to developing models to forecast the supply of, demand for, and price of energy on a national, regional, and global level. Thus, when we set out to choose a basic model for our own study in May 1982, we could choose from a wide variety of approaches. These models ranged in complexity from "highly aggregated" to "highly disaggregated."

Aggregated models are usually based on a "production function"—an equation or set of equations relating energy use to economic welfare via a number of external factors. Those factors could include the size of the population; the share of gross national product used to pay for energy; the flexibility of substituting among different types of energy, and between energy and labor; the costs of fossil and nonfossil sources of energy; taxes; and, for a study of the CO_2 problem, the effect of increasing levels of carbon dioxide on the economy.

The basic advantage of highly aggregated models is that their relatively simple analytic structure makes it easy to see the effects of changes in the values fed into them. Futhermore, many trials can be made with aggregated models. The main disadvantage is that the models do not make distinctions among different energy technologies, and among different regions of the world. For example, using either nuclear reactors



or solar photovoltaic cells instead of coal to generate electricity would reduce CO_2 emissions. However, these two technologies differ considerably in economic scale, environmental impact, method of integration into electricity grids, prospects for technological change, and other issues. But highly aggregated models, which typically incorporate only one fossil and one nonfossil fuel, cannot capture the implications of those differences.

Highly disaggregated models represent the other extreme. They include many geographic regions, a wide range of energy sources with separate prices and prospects for each, interregional transport of fuels, profiles of different customers for the energy produced, and thorough detail about economic factors. To the degree that their users can plug in meaningful data, highly disaggregated models provide more realistic results; in principle, they can explore in detail the relations among the economy, energy supply and demand, and technological change. But in practice, such models may be so complex as to be inscrutable to everyone except their developers. They may also demand an excessive amount of computing effort.

There are obvious limits on the ability of models, whatever their type, to forecast supply and demand over the longer term. Given the fact that outcomes depend on uncertain external factors, including unexpected events such as wars, the formation of oil cartels, and major technological advances, it would be folly to base present policy on specific predictions of energy supply and demand in, say, 2050. Models prove their value, however, when fed a wide range of possible values for the external factors. (We refer to possible, rather than plausible, values because modelers must make their own judgments about which assumptions are "beyond the pale.")

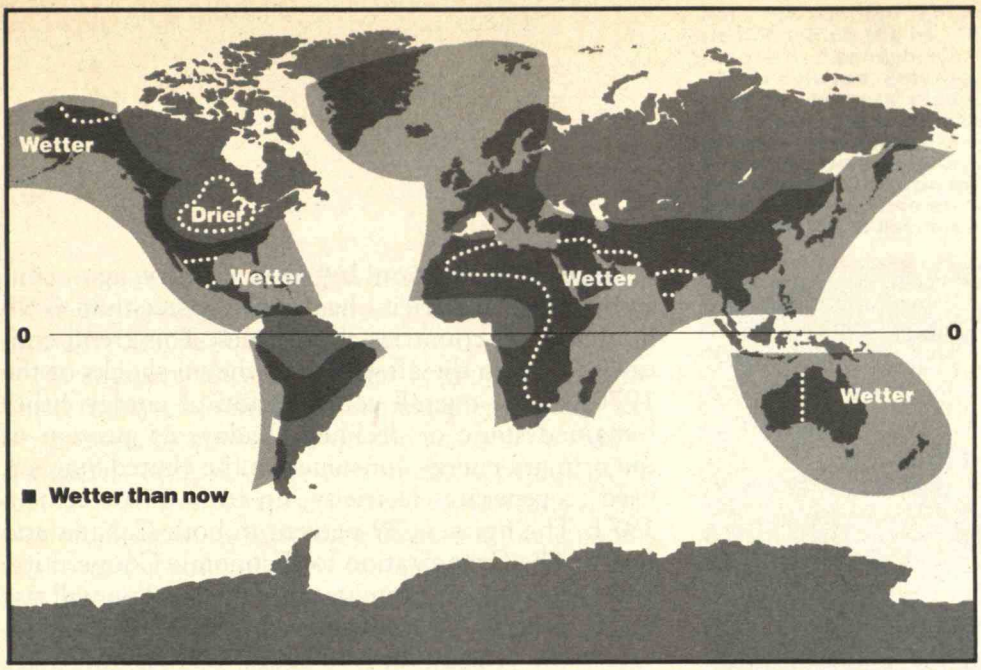
For our analyses of the greenhouse effect, we sought a model disaggregated enough to allow us to investigate such factors as the ease of substituting between fossil and nonfossil fuels, but aggregated enough to work without requiring unreliable or unavailable data. After studying the possibilities, we settled on a model of medium complexity developed by Jae Edmonds and John Reilly at the Institute for Energy Analysis in Oak Ridge, Tenn.

The model divides the world into nine regions, and considers nine primary sources of energy separately. These sources are coal; conventional oil and gas; unconventional oil and gas, such as oil shale and gas that lie in deep wells under high pressure; and four nonfossil sources of electricity—hydro, solar, biomass, and nuclear power. Modelers must specify the energy reserves available at any given time, and the minimum prices for extracting energy from those sources. The model adjusts actual energy prices until achieving a balance between global supply and demand. It also accounts for emission of CO_2 from fossil fuels at each stage of the fuel cycle. In dealing with synthetic gas from coal, for example, the model recognizes that carbon dioxide escapes both when the coal is converted into gas and when the gas burns. The model then uses such data to project energy use and release of CO_2 according to the type of fossil fuel, and the region of the world, up to the year 2050.

Assessing the Options

The key to the success of any modeling effort is the choice of external factors. To develop those factors for our model, we assessed various options involving energy availability and demand. Here, we highlight typical examples, which include the future use of coal, solar photovoltaic cells, prospects for a more-electric world, and opportunities for improving efficiency in end-use.

The large resources of coal justify a close examination. We estimate the amount available worldwide at 5 trillion tons. If any significant fraction of these resources is exploited, atmospheric CO_2 will increase well above the doubling level of 600 ppm. Other fossil fuels are much less threatening. Combustion of all the estimated recoverable oil and gas in the world will not raise the CO_2 level above about 450 ppm. And although oil shale and tar sands also con-



Trends from ancient and recent history show likely effects of a buildup of CO_2, and point to one key means of alleviating the problem. Studies of fossils from the altithermal era 10,000 years ago, when the earth was much warmer than today, indicate likely winners and losers from a global warming (near left). The words "wetter" and "drier" denote areas where change is especially likely to occur.

The chart (far left) shows how energy efficiency in the United States improved over the years. As the economy matured, electric power and liquid fuels increasingly replaced coal.

tain burnable carbon, exploiting them poses technical and environmental problems at least as daunting as those involved in coal use. This suggests that they will be less readily accepted.

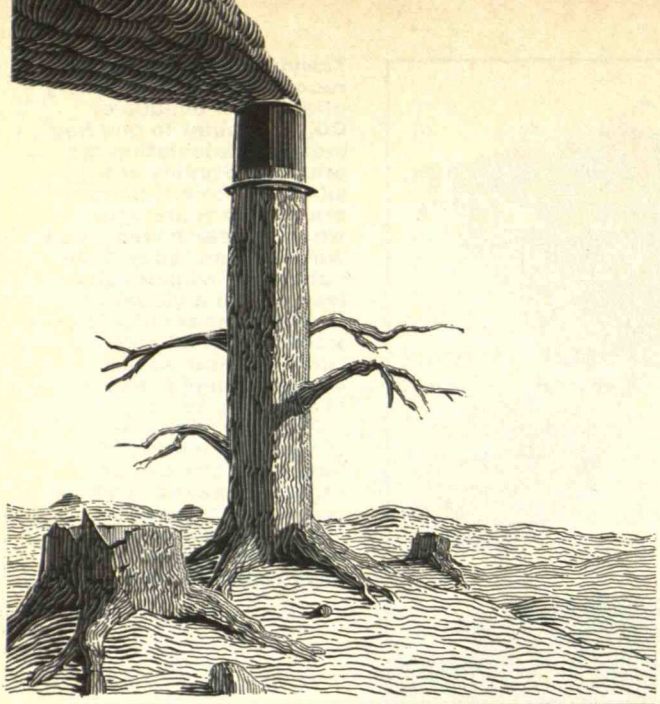
Environmental factors apart from the greenhouse effect may influence how coal is used, and thus reduce the buildup of carbon dioxide. The link between the sulfur emissions from coal combustion and acid rain, for example, may lead to legislation that limits coal use. On the other hand, new technologies such as fluidized beds, which burn fine particles at relatively low temperatures, promise to make coal use not only more environmentally benign but also more efficient—and thereby more attractive as a long-term solution to the world's energy needs. In other words, there are both substantial impediments to expanded use of coal and—apart from CO_2 warming—feasible solutions. The solutions will not be cheap. But because mining coal is relatively inexpensive, and methods of gasifying it and converting it into liquids such as methanol for transport are available, the world's vast resources will likely be exploited.

A devastating increase in global warming from increased use of coal is not inevitable, however. Three factors could help to save the situation: greater efficiency in the use of energy, a revival in the prospects for nuclear power in the United States and other countries, and greater use of various renewable resources. Taken together, these developments could allow burning of fossil fuels to increase only slowly, if at all. The CO_2 problem wouldn't disappear, but it would remain manageable enough to allow preventive or remedial action.

One prominent form of renewable energy is solar photovoltaic (PV) power, which is already in use in areas remote from electric grids. Widespread use of PV depends on significantly reducing the cost of both the PV cells, which convert sunlight to electricity, and components such as power-conditioning equipment (which converts direct to alternating current), support structures for the solar modules, and systems for storing electricity. In fact, the costs of cells have already fallen markedly. Experts estimate that by 1985, modules of PV cells will cost no more than $4 to $5 per peak watt in 1980 dollars, down from about $10 per peak watt today. Advances such as inexpensive automated methods of manufacturing PV cells of single-crystal silicon could reduce that to $1.50 per peak watt for the modules alone, and perhaps $3.00 per peak watt for complete systems exclusive of storage.

However, even that figure is not nearly low enough for PV to be widely adopted. Assuming a capacity factor of 20 percent to account for variations in energy collected between day and night and from winter to summer, and an interest rate of 15 percent per year on capital, it would produce electricity for 26 cents per kilowatt-hour (Kwh), excluding operation and maintenance charges. Electricity now costs from 5 to 10 cents per kilowatt-hour in the United States, depending on location.

PV prices could fall spectacularly if alternative cells under development, such as thin-film devices based on amorphous silicon, work successfully. We estimate an ultimate rock-bottom price of 60 cents per peak watt for complete arrays—which is equivalent to electricity at 5.2 cents per kilowatt-hour. In contrast with the 26 cents/Kwh figure, which would price PV out of the market for all but special purposes, a 5.2 cents/Kwh price looks very attractive when the sun is shining. However, neither PV sys-



The effectiveness of energy use can be increased by about one percent per year for decades without any social strain.

tems nor wind generators, which also depend on the sun, can meet base-load needs or peak demand without means of storing their output. Storage would certainly increase the reliability of those sources of energy, but it would also benefit base-load coal and nuclear plants by making off-peak capacity available to meet peak demand.

PV and wind power offer some specific advantages denied to coal and nuclear power. They can be used on the relatively small scale of several megawatts of power, which is well-suited to current trends of low growth in demand for electricity. Economies of scale made possible by mass production are already available at this level. In addition, the costs of conditioning, operating, and maintaining PV and wind plants will be lower than for rooftop-sized installations. And various indirect forms of storage—such as locating individual arrays far apart to increase the likelihood that the sun will be shining and the wind blowing steadily enough somewhere in the system—can compensate for the uncertain nature of those sources. Megawatt-sized PV systems are already operating or under construction at several locations in California. Their success suggests that PV could become a global option in the form of megawatt-sized "farms" tied to local or regional utilities.

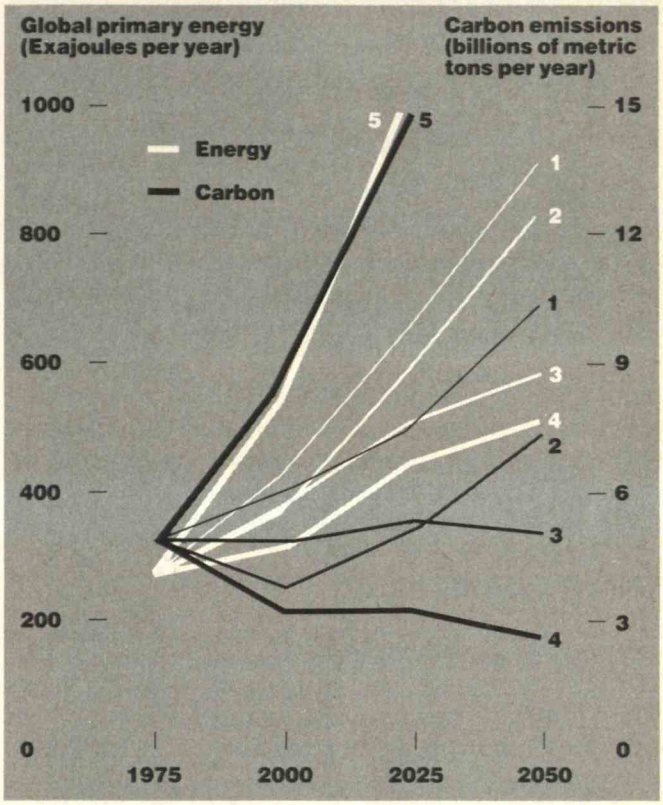
Since electrification began a century ago, consumption of electricity has grown faster than GNP in almost all countries at all times. This trend continued even in the aftermath of the oil shocks of the 1970s, when overall consumption of energy either remained static or declined. Today, 35 percent of the primary energy consumed in the United States is used to generate electricity, up from 25 percent in 1972. The figure is 39 percent in both Canada and Japan. The Organization for Economic Cooperation and Development estimates that the fraction will rise to 45 percent or more in industrialized countries before the year 2000. And Third World nations are following the same path. Taiwan and South Korea have leapt from low to high electrification in less than 30 years, and populous nations such as China, India, and Indonesia are in process of electrifying.

Electricity offers advantages in both supply and demand. It satisfies customer's needs for precise control of clean energy, not only for lighting, motors, and communications but also for industrial applications such as making steel and heat treating metals. Reversible heat pumps now outperform furnace air conditioners in many locations. On the supply side, many new methods of electricity generation are nonfossil; they include nuclear, PV, and wind power as well as more traditional hydropower. Thus, a more electric future could well increase the nonfossil share of total primary energy use and hence reduce CO_2 emissions.

Given the cyclical nature of electrical demand, economical storage of power will be a major factor in determining the success of extra reliance on electricity. Electricity can be stored either directly or indirectly.

Potential hydropower can be stored cheaply and directly by either damming natural rivers or pumping water. However, the ecological cost of many dams is high. Advanced batteries, such as sodium-sulfur units, could be more widely used to store electricity from PV and wind. These have higher storage capacity and power ratings than conventional lead-acid batteries, and can be charged and discharged through many cycles. While their costs remain high, the prospects for advanced batteries costing $60 per kilowatt-hour appear bright. Assuming that such batteries are charged and discharged 80 percent each day, and that the costs of auxiliary equipment, service, and replacement equal those of the batteries themselves, the system could perform its storage

Four "CO_2-benign" scenarios, in which the increase in atmospheric CO_2 is delayed, emerge from the authors' study. No. 1 has coal at present prices, some nuclear power, no solar power, and small arithmetic increases in end-use efficiency. No. 2 assumes successful development of solar and lower nuclear costs. No. 3 includes cheaper coal than No. 2 but also geometric improvements in efficiency. No. 4 combines all nonfossil and high-efficiency trends. No. 5 is a high-energy scenario developed elsewhere.



function for 4 to 5 cents/Kwh. Coupled with cheap off-peak power, storage at this price would be very attractive for peak demand.

For indirect storage, interest is growing in combined utility-customer load management, which can be thought of as storage on the customer's side of the meter. So low is the cost of this technique that several load-management systems are already in operation. Solid-state switching devices at the customer's location, controlled by signals transmitted along the power line, can switch off or reduce usage of electricity by that customer. Consider that 36 percent of all electricity generated in the United States is used for various heating and cooling tasks, such as refrigeration and heating water. Those tasks use devices with considerable thermal inertia that can be left to "coast" for several minutes, and sometimes for hours, without adversely affecting the user. Even if only half this load comes in blocks large enough to be worth the effort, about 18 percent of the country's total electricity use is storable in some way. That enables the electric power system to accommodate fluctuations from sources such as PV and wind power.

What this means is that future electric power systems with storage capacity on both sides of the meter could use significant amounts of PV and wind power, combined with nuclear and, where available, hydro. The optimum mix would depend on the specific economic, environmental, and sociopolitical factors of a particular area. However, all such systems would help avoid significant increases in atmospheric CO_2.

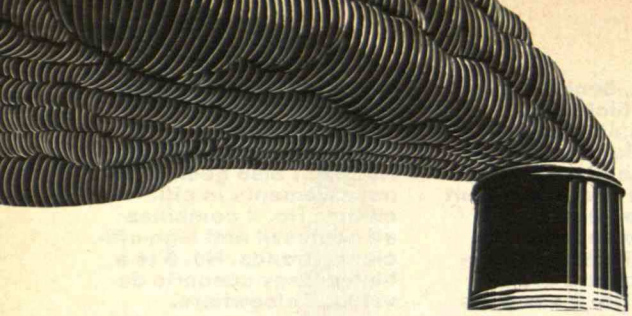
The Need for Effective Use of Energy

One of the most important conclusions of our study is that more effective end-use of energy can reduce global demand significantly. The past century of U.S. energy use illustrates the point. The amount of energy consumed per dollar of GNP, corrected for inflation, rose from 1880 to 1920. But then, as a more mature economy both increased its energy efficiency and moved toward more service-oriented and less energy-intensive industries, the ratio dropped.

The U.S. experience shows how quickly the growth of energy and GNP can be decoupled. From 1920 to 1945, real energy prices stayed almost constant while the ratio of energy consumed per dollar of GNP declined by about 1 percent per year. From 1945 to 1973, energy prices dropped while the ratio hardly changed. The decade from 1972 to 1982 saw a dramatic decrease of more than 2 percent per year in the ratio, driven by large increases in energy prices and a growing awareness that investments in more efficient use of energy pay well in terms of both economics and energy security. Many other OECD countries did as well as the United States, or better, in decoupling their energy use and economic growth during the same period. Moreover, there is persuasive evidence that we are far from the limits of what can be achieved by more efficient energy usage.

Of course, this does not imply that the U.S. economy is a model that other countries should follow in detail. Our point is simpler: that total energy per unit of real output generally declines with increasing technological, social, and economic complexity. One of the most energy-intensive of all cultures is the primitive slash and burn. The point is particularly important in the developing countries, where most of the world's future growth in energy use will likely take place.

Overall, we believe that the effectiveness of energy use on a global scale can be increased by about 1 percent per year for decades without any social



The rate of increase of atmospheric CO_2 from burning fossil fuels can be significantly reduced through CO_2-benign strategies.

strain. This seemingly small figure leads to a halving of energy use by the year 2050 and a 50 percent reduction in CO_2 emissions. This result is quite independent of the effect on CO_2 of any shifts to nonfossil sources for primary energy supplies.

What the Models Show

Based on these assessments, we constructed 11 different scenarios for energy use and CO_2 emissions using the Edmonds and Reilly model. Four of them were "CO_2-benign." They are shown in the figure on page 55, together with a scenario developed by the International Institute for Applied Systems Analysis (IIASA) in 1979, which involves continued use of coal at present prices and no increase in solar power. Our most CO_2-benign scenario combines all possible nonfossil trends, including successful development of solar power, lower costs for nuclear power, a 1 percent annual improvement in end-use efficiency, greater availability of unconventional energy resources, and higher coal prices. Other curves fall between these extremes.

Even the situation with the least change in current conditions implies an increase of atmospheric CO_2 to just 420 ppm in 2050, in contrast with the doubling to 600 ppm suggested by the IIASA scenario. This means that, while technical and other limits will restrict the range and composition of world energy use, the bounds of possible increases in atmospheric CO_2 in the future appear to be fairly wide—a spread of a factor of five or more by the middle of next century. More important, the modeling shows that the rate of increase of atmospheric CO_2 from burning fossil-fuels can be significantly reduced through CO_2-benign energy strategies.

Articles on carbon dioxide and climate change usually end with the observation that the future results of increased CO_2 are potentially serious, that an effective response to the problem must be international in scope, but that achieving the required consensus will be difficult. This overall statement has the virtue of sounding both high-minded and realistic; moreover, it is probably true. Given the world's dependence on fossil fuels, a prerequisite for any concerted action on CO_2 beyond continued research is the unambiguous identification of a warming signal in the noise of the climate's natural variations The predicted date for the signal depends somewhat on the contribution of other greenhouse gases. However, all analyses show that conclusive evidence of a human-induced greenhouse effect will not emerge until some time between 1990 and the early 2000s.

What will happen then is difficult to predict. But several climate researchers have noted a potential convergence of self-interest and leverage in limiting CO_2 emissions among the United States, the Soviet Union, and the People's Republic of China. Together, these three nations account for more than 90 percent of known coal resources. Two of them, the United States and the Soviet Union, stand to be net losers as a result of global warming. Thus, in principle at least, these countries could mine enough coal to satisfy their own needs while curtailing exports in the name of "responsible action" to deal with the CO_2 problem. That approach is not likely to work over the long term.

We see an interesting parallel with efforts to prevent the proliferation of nuclear weapons. The major international instrument for that end, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), was largely the fruit of an agreement between the United States and the Soviet Union. The two superpowers perceived that life in what the political analyst Albert Wholstetter of the University of Chicago has called "a nuclear-armed crowd" would not be in their best interests. They convinced other countries to forego acquisition of nuclear weapons. In exchange, the two superpowers pledged that they would provide full access to civilian nuclear technology and negotiate an early end to the nuclear arms race.

The "NPT bargain" has been largely successful in preventing the spread of nuclear weapons. But the consensus is fragile, and many states without nuclear weapons are unhappy with the superpowers' failure to reduce their own nuclear arsenals, and to share their nuclear technology more fully. Although these

Before you work anywhere, take a look at the tools we work with.

NASA's space shuttle. For Air Force officers working as electrical or aerospace engineers, the challenge is just beginning. In fact, from laboratories to lasers to launch pads, we have exciting projects and management opportunities very few employers can offer.

For example, we are developing experiments that will be an important part of the space shuttle's cargo in the years to come. Experienced Air Force engineers will work as shuttle mission planners and as astronaut flight controllers.

If you have an electrical or aerospace engineering degree, or soon will have, we may have a challenging future for you as an Air Force officer. It's a future that demands the vision and commitment of people like you. And it's vital to our country.

For more information about Air Force engineering opportunities, mail the card. Or call toll-free 1-800-423-USAF (in California 1-800-232-USAF). Better yet, send your resume to HRS/RSAANE, Randolph AFB, TX 78150. There's no obligation.

AIR FORCE

A great place for engineers.

Different Routes to the Policy Options

Two analyses of global warming, published on successive days last October, drew very different reactions from government officials and the CO_2 research community. *Can We Delay a Greenhouse Warming?* by Stephen Seidel and Dale Keyes of the Environmental Protection Agency's Strategic Studies Staff was deplored as alarmist by President Reagan's Science Advisor George A. Keyworth II and other members of the executive branch. *Changing Climate*, by the Carbon Dioxide Assessment Committee of the National Academy of Sciences, was called even-handed and constructive. In fact, both reports reached many similar scientific conclusions and policy options. But the two groups arrived at the options in ways that left very different impressions.

Points in common include:

☐ Atmospheric carbon dioxide is likely to double by, or soon after, the middle of the next century, causing considerable climate change.

☐ Other greenhouse gases such as the nitrogen oxides and the chlorofluoromethanes, can cause a significant warming if left uncontrolled.

☐ The sea level will probably rise by 2 to 17 feet in a century or so as a result of global warming.

☐ Worldwide taxes on the use of fossil fuels will have little effect in reducing the amount burned (note the modest influence of post-1973 prices on the global use of oil).

☐ Because costs and benefits of climate change will affect countries and regions unevenly, a long-term global strategy to deal with global warming will be politically difficult to reach.

☐ It is important to learn how to adapt to what may be inevitable climate change.

☐ Humans have no historical experience with significant climate change.

☐ Because many uncertainties exist, we need more research and better measurements.

The bottom line of the EPA study is that some degree of CO_2-induced climate change is inevitable. Bans on the use of fossil fuels will not work. The problem is long-term, and the world's energy patterns change only slowly. Therefore we should aim now toward less reliance on fossil energy sources and learn to adapt to changes that are already in train, by developing new crops that thrive in drier conditions, erecting coastal dikes, and the like.

In 495 single-spaced pages, the NAS report covers with authoritative detail such issues as the uptake of CO_2 by oceans and planets, the present status of monitoring carbon dioxide, potential effects of the warming on agriculture and sea level, and overall policy implications. Unfortunately, much of the discussion is couched in such neutral terms that the conclusions are often difficult to fathom. Readers are tempted to ignore the evidence that many suggested means of alleviating global warming won't work, because the argument is made so subtly.

Consider dikes, which might protect populations and land against rising sea levels. The fact that the Netherlands has built them successfully for centuries is explained at some length. Of course, the report continues, dike-building won't work very well in Bangladesh, so it may be necessary to abandon the foreshore there. This both ignores the importance and vulnerability of the world's ecologically complex and productive foreshores and neglects the fact that the Dutch had the choice of building or not building their dikes, whereas the decision would be imposed on the Bangladeshis. And the report short-changes all the other Bangladeshes of the world as well.

The academy report predicts that the consequences of a CO_2 buildup will be harmful, and recognizes that changes designed to alleviate these results will take several decades to work. But the report concludes that it is too soon now to do anything except measure, compute, and think—and, other things being equal, accept nonfossil options in preference to fossil ones.

Neither the EPA nor the NAS report includes any detailed analysis of CO_2-benign energy options. That, however, is the main thrust of our new study of the problem.—*D.J.R.*

complaints contain an element of rhetoric, it seems clear that global stability cannot be achieved through a policy of "preaching water and drinking wine."

So too with CO_2. Policies of denial would not work because plenty of coal exists in India, Indonesia, Botswana and elsewhere for a large coal-based economy. Cooperation among the major powers in promoting research on climatic change is important but not enough. What is needed is leadership in formulating and carrying out energy and environmental policies that are in the best interests of all nations. This effort must take place before clear evidence of a warming and identification of the winners and losers. Such policies should include international programs to increase energy efficiency, such as dissemination of information, development of devices tailored to local needs, and loans of the required capital. Also important are research, development, and demonstration of nonfossil systems for generating electricity that incorporate storage on both the generator's and the customer's side. And finally, both the United States and the Soviet Union should encourage low population growth, which would not only reduce demand for energy, but also lessen stresses on land use, food resources, and social order. Together, these measures could ensure that use of fossil fuel increases slowly, if at all. The problem of atmospheric CO_2 buildup won't disappear. But it will develop so slowly as to enhance the chances for action that can alleviate it or overcome it altogether.

DAVID J. ROSE is a professor of nuclear engineering at M.I.T. MARVIN M. MILLER is a principal research scientist in M.I.T.'s Energy Laboratory. CARSON AGNEW recently left his post of assistant professor of engineering economics at Stanford University to join Hughes Aircraft Corp.

THE BIGGEST INCENTIVE OF ALL: WE'RE PRO-BUSINESS

In Maryland, we offer you a solidly pro-business attitude that's here today and here tomorrow. A commitment to help protect the profits we know are the lifeblood of Maryland. And that's making Maryland the best place in America to do business. Isn't that the biggest incentive of all? Come for the carrot. You'll stay for the greens.

MARYLAND

Write or call Michael Lofton, Director, Business and Industrial Development, Dept. 127, 45 Calvert Street, Annapolis, Maryland 21401, (301) 269-3514.

Moving People and Goods Before the Year 2000

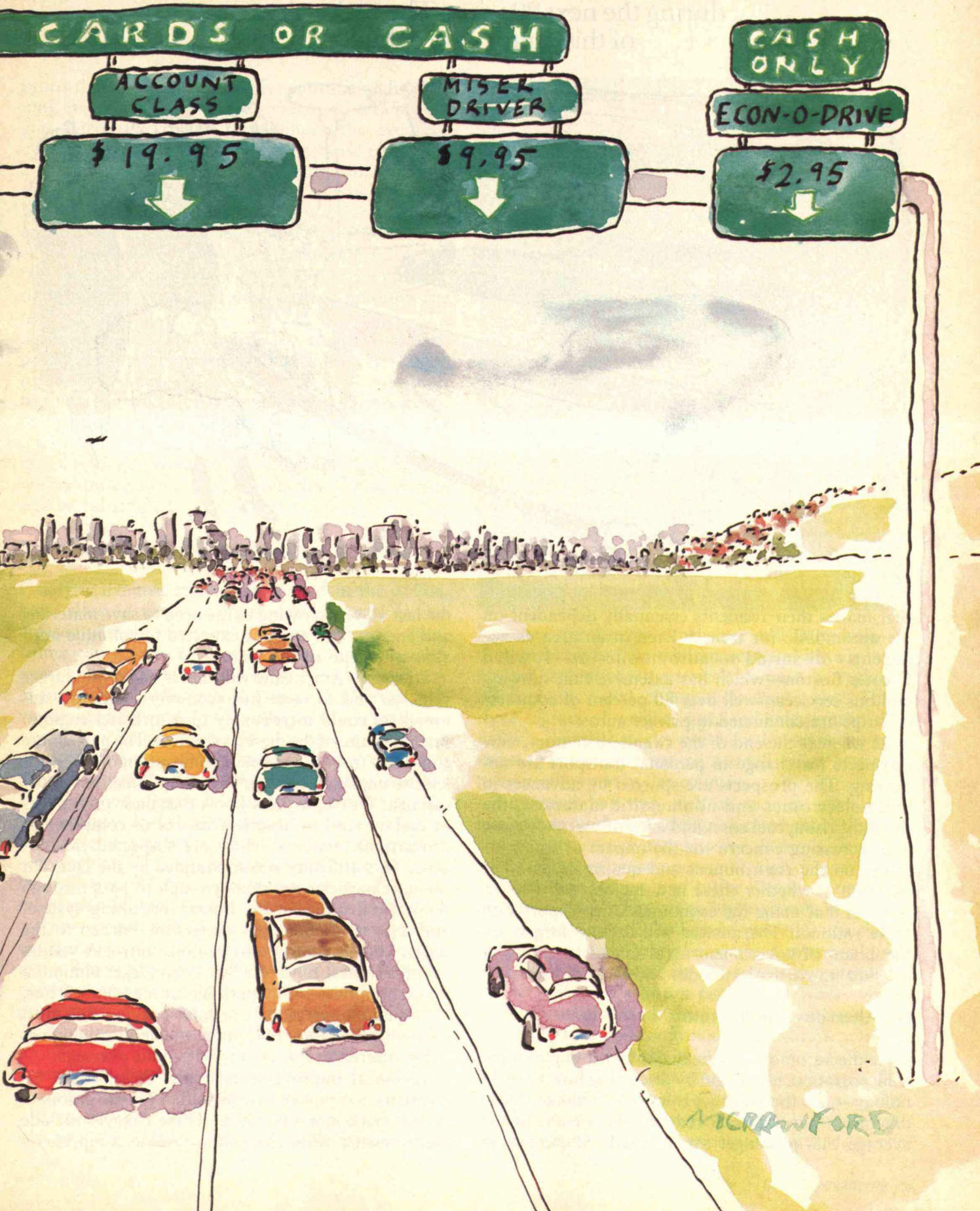
BY DAVID GORDON WILSON

Only modest technological changes are likely in personal transportation systems by the end of the century. But new ways of allocating their costs suggest that their performance can be significantly improved.

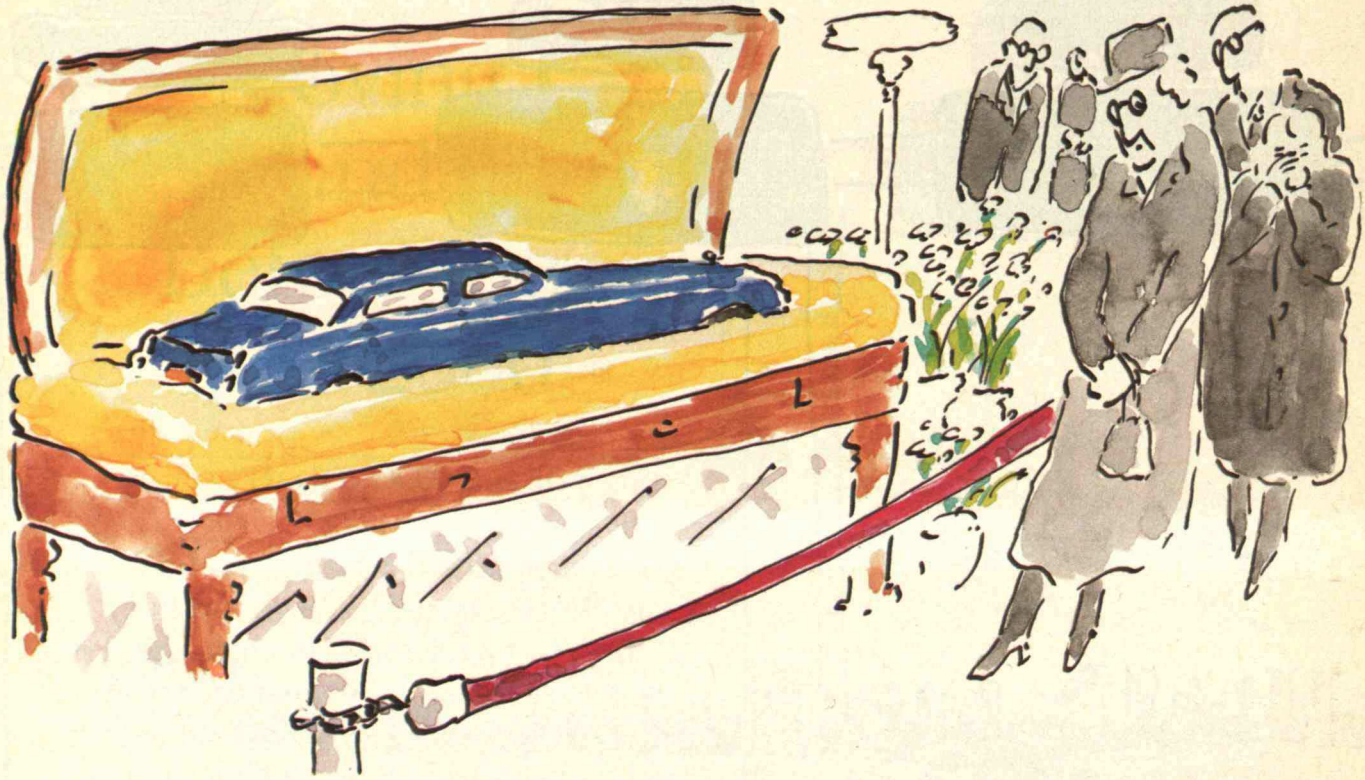
ONLY through war and crime do people more adversely affect the lives of their neighbors—without any form of compensation—than when they transport themselves, their goods, and their wastes. Yet society does not make users pay for the full costs of transportation, which include effects such as noise, pollution, and congestion. This inequity stifles the incentives for innovation and change.

This frustrating situation stems chiefly from automobile use, as the automobile is the predominant mode of personal transportation in developed countries, and developing countries are doing their utmost to catch up. Many U.S. cities such as Los Angeles have developed in a way

ILLUSTRATIONS: MICHAEL CRAWFORD


CARDS OR CASH
ACCOUNT CLASS
$19.95
MISER DRIVER
$9.95
CASH ONLY
ECON-O-DRIVE
$2.95
MCRAWFORD

Dramatic changes in passenger cars and highway trucks seem unlikely during the next 20 years. The major changes of this century are behind us.



that makes their residents essentially dependent on the automobile for transit. Even in an area as apparently ill-suited to automobiles as crowded Greater Boston—which has extensive rail, subway, and bus services—well over 80 percent of commuting trips are conducted in private autos.

As we near the end of the twentieth century, new prospects for change in personal transport are appearing. The prospects are spurred by advances in microelectronics and nonmetallic materials, the threat of rising fuel costs and even of fuel shortages, and increasing concern for the impact of transportation on the environment and quality of life. The question is whether these new factors will lead to changes that make the economics of transportation more rational. The answer will depend largely on the extent of government involvement in taxing or subsidizing particular modes and technologies.

No Alternative to the Auto

Since the automobile is the major factor in passenger transportation, let's begin by discussing how its technology—and therefore its role—may change. Manufacturers have already reduced the weight of the average U.S. passenger car by nearly 50 percent in the last 10 years, owing to the need to save materials and energy. This trend is expected to continue until almost the end of the century.

To satisfy Americans who insist on having larger vehicles, and to meet fuel-economy standards, automakers could increasingly turn to diesel engines. But the future of the diesel is clouded. The particulate emissions from the engine's combustion of oil droplets are unpleasant enough to see and smell as smoky exhaust. Worse, we now know that these tiny specks of carbon tend to absorb a variety of complex hydrocarbons, many of which are suspected carcinogens. This difficulty is compounded by the fact that the host particles are small enough to pass through the natural filters in the human breathing system, and thus to deliver their dangerous burden to the lungs. Diesel engines also produce nitrogen oxides at rates several times the legislated target minimum for automobiles with spark-ignition engines. Thus, U.S. manufacturers are not fully backing this most efficient of engines, and many of the diesel engines being offered in this country are built overseas.

Technical improvements to the diesel could increase its acceptance as a substitute for the gasoline-fueled spark-ignition engine. These changes include high-pressure turbocharging; variable compression

ratios that adjust the engine for starting, high-economy cruising, and full-power operation; ceramic engine parts that reduce or eliminate the need for cylinder cooling and thus further increase efficiency; and increased turbulence in the combustion chamber to promote cleaner burning and raise power output. In addition to reducing the particulates in diesel emissions, these improvements would increase the engines' low power-to-weight ratio. If the promise of improved performance and efficiency is even partially fulfilled, the diesel may be used well into the next century.

However, if diesel engines continue to be suspected of adversely affecting health, and if various proposed exhaust-cleaning systems are found ineffective, they will probably be legislated out of contention for use in passenger cars. In that case, the question becomes whether conventional spark-ignition engines—which are steadily being improved—will continue to be used or whether a new engine will be substituted.

Runners in the Propulsion Race

Catalytic exhaust systems, first used in the 1970s, have allowed engine compression ratios to be increased without increasing noxious emissions. Electronic control of carburetion and ignition has also greatly improved the economy of the spark-ignition engine while reducing emissions. Additional advances are likely within a decade: more efficient combustion systems to permit "leaner" burning or perhaps two-stage "rich-and-lean" operation, improved lubricants to reduce friction, and ceramic cylinders and piston crowns to increase operating temperatures and thus efficiency.

The trends toward smaller vehicle size and greater efficiency are likely to continue. Small passenger cars that get over 85 miles per gallon will likely be on the market within 10 years. The question is whether the price of fuel will rise, or the supply decrease, fast enough to make these small vehicles acceptable to many Americans. If the demand for larger vehicles persists—and especially if some of the expected improvements in spark-ignition engines prove difficult to accomplish—alternative propulsion systems will probably be developed. There are three principal contenders: battery-powered electric systems, the Stirling engine, and the gas turbine.

Conventional lead-acid batteries are less than satisfactory for electric-powered automobiles. Those batteries are heavy, expensive, and dangerous in crashes because they contain acid and have a large mass. Conventional batteries also must be replaced after about 2,000 charge-discharge cycles. These three factors of weight, cost, and safety mean that today's electric vehicles must use low-capacity batteries that confine them to a small range at rather low speeds, even in flat country.

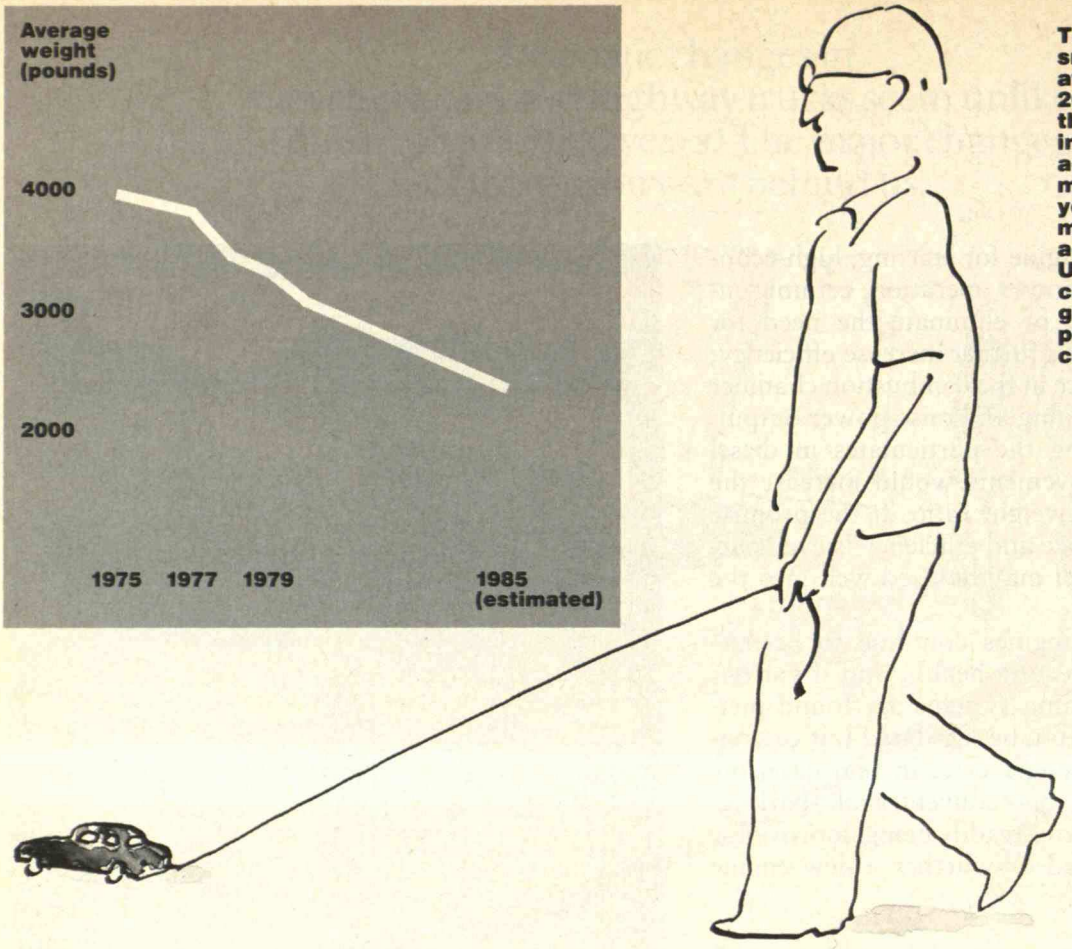
General Motors thinks this experimental two-passenger commuter, or TPC—shown parked in front of the smallest G.M. car now built in the U.S. — may be the shape of things to come. With an 0.8-liter, three-cylinder engine and a five-speed transmission, TPC runs 68 miles per gallon of gas in typical commuter traffic and 95 mpg on the Environmental Protection Agency's highway driving cycle.

TPC's design is distinguished by very low aerodynamic drag, including flush glass, front air dam, smooth contours, and inside-mounted rear-view mirrors. GM says it has no current plans to produce TPC for the U.S. market. The present design does not meet all U.S. emission and safety standards.

Advanced batteries such as sodium-sulfur, lithium-sulfur, and other designs can be much lighter, but all have disadvantages. For example, sodium-sulfur batteries must operate at high temperatures using molten sodium and sulfur. Because hoped-for breakthroughs in battery technology remain elusive, the present outlook for battery-powered vehicles is dim: they will probably be confined to special-purpose local use, at least for the rest of this century.

The Stirling is a piston engine that works on an enclosed small mass of trapped gas, usually hydrogen. Fuel is burned continuously to heat the trapped gas. This gas drives the engine as it expands toward an air-cooled, low-temperature heat exchanger. The Stirling is highly efficient—about the same as a diesel—but is even more massive and uses large quantities of expensive, high-temperature metals. No one

PHOTO: GENERAL MOTORS



Today's trend toward smaller cars will continue at least until the year 2000. The chart shows the mass of the materials incorporated into an average American-made automobile for the model years indicated, and estimated for 1985. The average weight of cars on U.S. highways has declined at least as rapidly, given the numbers of imported compact and subcompact vehicles.

has yet devised a fully satisfactory high-pressure seal to contain the hydrogen in a practical engine. However, if such a seal could be devised, and if ceramics could be used in place of the high-temperature metals, the Stirling engine would be a considerable improvement over the present diesel engine. It emits negligible amounts of pollutants, tolerates a wide range of fuels, and is very quiet. But by the time these improvements are made and the engine is redesigned for production, the diesel or gas-turbine engine will also be greatly improved, so the future of the Stirling engine does not seem promising.

The gas turbine is the third alternative propulsion system. This engine has some similarities to the diesel and conventional spark-ignition engines: air is compressed, fuel is sprayed in and ignited, and the hot compressed gases expand to turn the engine shaft. These processes occur sequentially in the cylinder in diesel and spark-ignition engines. Thus, cast-iron engines with aluminum cylinders and pistons are capable of withstanding the stresses from the brief pulses of combustion at temperatures as high as 2,250°C. In contrast, these processes take place continuously in the gas-turbine engine. Because the combustor and turbine must withstand a constant flow of hot gases, gas temperature must be much lower than in a spark-ignition or diesel engine. The gas-turbine engine compensates by having more efficient compression and expansion processes, and it should soon be capable of an efficiency considerably higher than that of the present diesel.

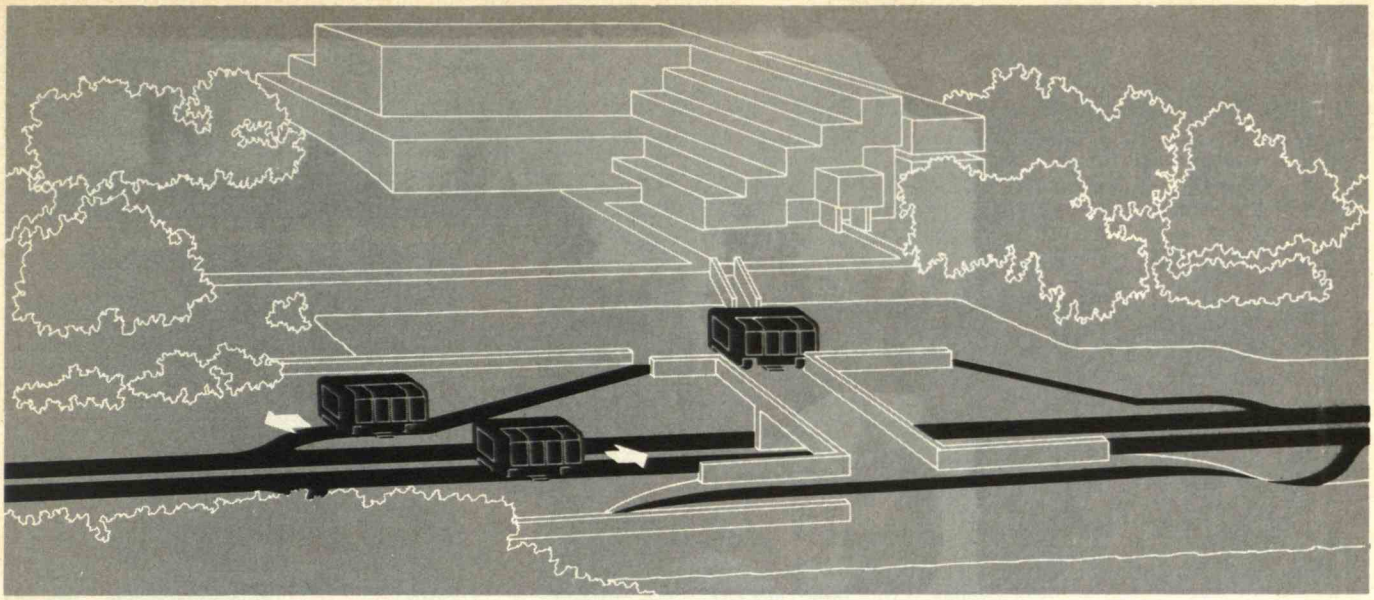
Like the Stirling engine, the gas turbine produces negligible amounts of pollutants because of its continuous combustion. But also like the Stirling engine, the gas turbine requires large quantities of high-temperature alloys. However, the prospects for substituting ceramics or other nonmetallic materials are bright. If these prospects materialize, the gas turbine will probably become the standard engine for vehicles requiring power outputs greater than 125 horsepower.

Except for these developments, no dramatic change in passenger cars or highway trucks seems likely to occur during the rest of this century. The major technological changes of the second half of the twentieth century—the transition to front-wheel drive, disc brakes, and improved suspensions—are behind us.

Rationing the Roadways

Nor are dramatic changes in the highway system, comparable to the development of the interstate system after World War II, likely to occur. Completion of that system has virtually eliminated congestion on intercity highways, and the spotlight has returned to

DIAGRAMS: OMNIGRAPHICS



If mass transportation can turn the corner to profitability, there is virtually no limit to the improvements that can be conceived. Perhaps the ultimate is this concept for efficient, personal service with small vehicles on a guideway. Each vehicle would be programmed to stop only at stations required by its 6 to 8 occupants, thus providing the personalized service now denied to users of mass transit. Indeed, the points of boarding and alighting need not be adjacent to the main guideway—a feature that suggests even more flexibility in meeting riders' needs.

crowded urban arteries. Here Americans could see a dramatic change in the way we organize and pay for urban transportation.

The automobile has conferred unprecedented personal freedom on its users, but that freedom has placed burdens and costs upon others. One economic analysis, for example, suggests that a driver who adds a vehicle to a crowded street imposes delays on other drivers valued at $5 to $10 per mile. Environmental costs should also be included, and so should the cost of the increased risk of accident and the decay of public transit—the latter disproportionately affecting the poor, the young, and the old. Furthermore, when traffic congestion becomes acute, public money—derived not only from fuel and motor-vehicle taxes but also from general revenues that might otherwise be devoted to schools, recreation, and public services—is used to build new highways to alleviate the congestion.

But sooner or later, towns and countries will have to find fairer ways to apportion the costs of the automobile, and to limit the space given over to arteries and parking. Singapore and Hong Kong have recently adopted new policies to deal with serious congestion, and transportation planners and policymakers elsewhere are watching these experiments with great interest.

Singapore has rationed its roads. Motorists are allowed to travel only on alternate days, just as U.S. car owners were allowed to buy fuel only on "odd" or "even" days during the energy crisis of 1973.

Hong Kong is introducing road-use pricing, a more radical approach to alleviating congestion. Sharply increased vehicle taxes and other draconian measures failed to limit the growth of traffic in the 1970s. Therefore, the government decided in 1983 to begin charging motorists for using the highways, just as users of telephones and central computers are charged for those private services. Like charges for other utilities, highway-use rates will be sharply higher at times and places of congestion, and quite low at times and places of low demand.

The Hong Kong system requires that each vehicle be fitted with a transponder roughly the size of a tape cassette. Streets subject to congestion are equipped with interrogator-recorders connected to a central computer. As vehicles pass over these sensors, they are identified by the transponders they carry. The computer assesses charges according to location and time of day, and each vehicle's owner is billed for road use at the end of every month.

This extension of the concept of toll roads to all public thoroughfares marks the first time that motorists can be routinely assessed something approximating the full social costs of operating their vehicles. The question, of course, is how this system

Can $3,000 Japanese-made mini-micros win the hearts of average American families? For the answer, Purdue engineers have put the small cars in the hands of 15 families for a three-year trial. The mini-micros are smaller and (at 1,300 pounds) much lighter than cars now sold in the U.S.; they average 50 mpg and travel best at about 45 mph.

The families have "chits" for the use of larger American cars from a "shared fleet" when they want to make out-of-town trips. After three years, says Professor F. T. Sparrow, Purdue will have some useful data on how the test families have used their small cars and how they've liked them.

will affect car owners' decisions on when and where to drive. If the experiment succeeds in reducing road congestion, many nations will undoubtedly introduce some form of road-use pricing.

Some aspects of the Hong Kong system would make it unacceptable in the United States and many other countries. One problem is that anyone with access—legal or otherwise—to the central computer could, in theory, discover the movements of every vehicle at all times. That prospect conjures up images of spying and other infringements of privacy. Enforcement of the requirement that motorists equip their cars with transponders seems likely to be difficult and costly in the Hong Kong system.

But these problems are not inherent to all systems of highway-use charges. For example, in a scheme developed for the British government in 1960, each vehicle's owner would install a meter and purchase in advance—like modern magnetic-stripe subway tickets—units of service that would be expended as the vehicle passed over electromagnetic activators in streets and highways. Activators could be spaced at various intervals to make the most congested routes the most expensive, and owners who tampered with their meters would discover their credit balances automatically erased.

A principal constraint on any form of road-use charge is the difficulty of instituting a small-scale trial: the system has to be introduced countrywide. In a nation such as the United States, the cost of even a minor design "bug" would be enormous. Thus, Hong Kong, with its small size and high traffic density, is an ideal place for testing a possible model for traffic constraint throughout the world.

One appealing aspect of a system of road-use charges is that its success would make public transit more attractive and provide revenue for its improvement. If congestion were reduced, surface vehicles—buses, trolleys, and street cars—carrying more people could move faster than they do now. They would then attract still more riders and generate further increases in revenue. There is no obvious limit to the improvements in quality and frequency of service that could be generated from this positive feedback.

Human-Powered Transportation

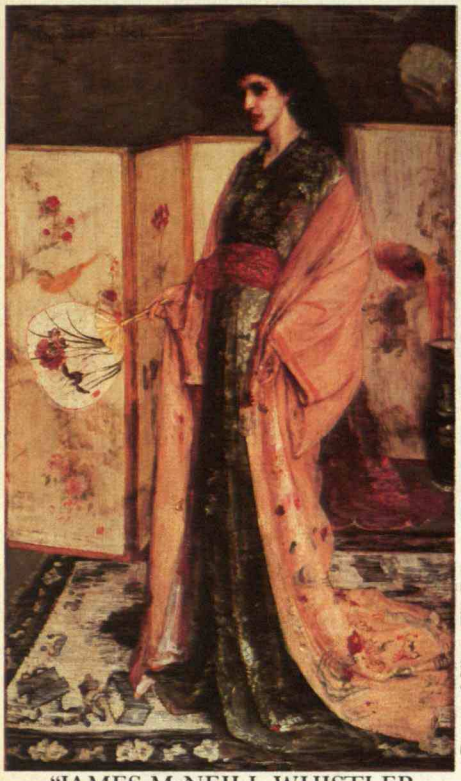
The bicycle, which uses the least amount of energy per mile of any moderate-speed land vehicle, is at the opposite pole among future urban transport alternatives. The bicycle was a major commuting vehicle in Europe and the Third World from 1890 to 1945. But changing fashion, low-cost energy, and huge subsidies to other forms of transportation have encouraged people to live too far from work for bicycle commuting, and bicycle use has decreased sharply, even in many developing countries.

In the past few years, however, we have seen a renaissance in the development and use of human-powered vehicles, owing chiefly to the rising cost of energy, and also to increased interest in physical fitness. In a few European cities such as Rotterdam, over 40 percent of all person-trips are made by bicycle. Although that proportion is far lower in most

Continued on page 87

PHOTO: PURDUE UNIVERSITY

THIS YEAR, AT&T BRINGS YOU MASTERPIECES, CLASSICS, AND THE MOST MODERN ART IN THE WORLD.

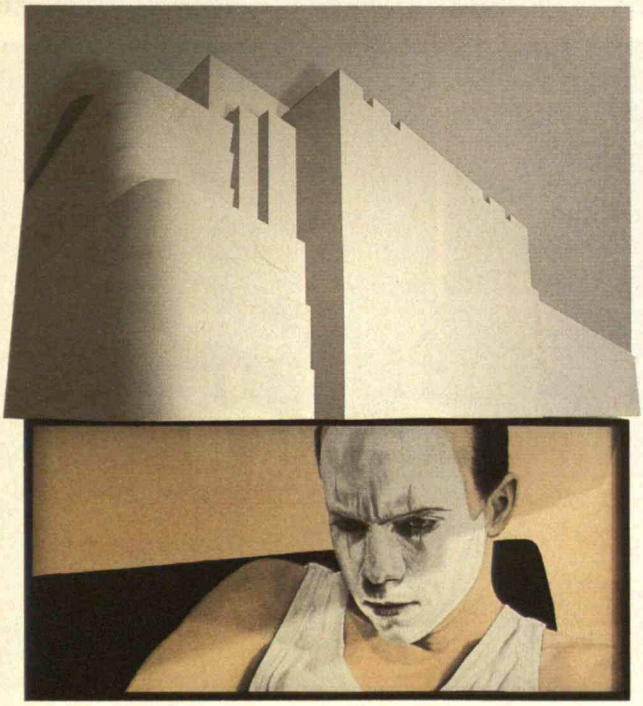


Rose and Silver: The Princess From the Land of Porcelain

"JAMES McNEILL WHISTLER
AT THE FREER GALLERY OF ART,"
SMITHSONIAN INSTITUTION
MAY 11—DECEMBER 1

Juilliard String Quartet

"AT&T PRESENTS CARNEGIE HALL TONIGHT"
WEEKLY ON GOOD MUSIC RADIO STATIONS



© Robert Longo, Collection: The Museum of Modern Art

THE MUSEUM OF MODERN ART
"AN INTERNATIONAL SURVEY OF RECENT
PAINTING AND SCULPTURE" MAY 17—AUGUST 7

In 1984, AT&T continues its commitment to bring you great art and great artists.

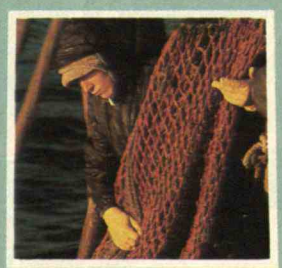
We bring you 300 artworks of remarkable variety by an American master, a series of performances from one of the world's most revered concert halls, and a thought-provoking exhibition of today's most recent art selected from 16 countries.

AT&T

Catch as Catch Can

BY BRUCE D. STUTZ

With more U.S. fishermen using better-equipped boats competing for a limited resource, both fishermen and fish are in trouble.



FISHING
A SPECIAL REPORT

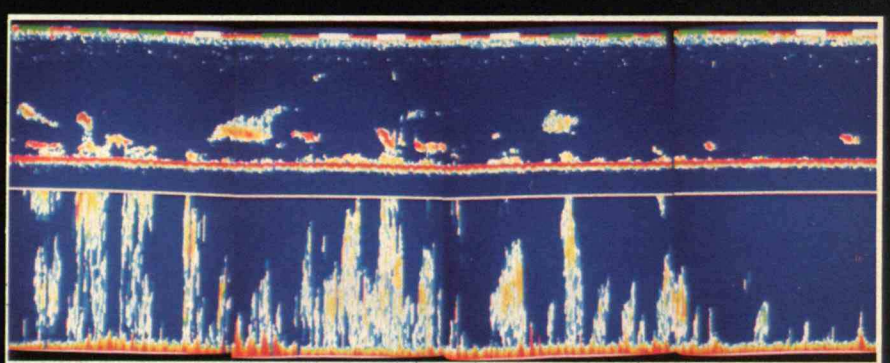
DANNY Hand is an acknowledged "highliner," a commercial fisherman at the top of his profession. From his home port on the south shore of Long Island, N.Y., Hand pilots the *Shinnecock*, a 74-foot stern trawler, on trips lasting from one to three days. The trips take on a steady cycle of setting gear, dragging nets, hauling in, sorting fish, and setting gear once again. Hand's skill is reflected by the less experienced skippers who follow at *Shinnecock*'s stern—the "tail boys," he calls them.

The foremost attribute of highliners is their ability to find fish, and Hand's wheelhouse attests to that requirement. Gone are the days when wheelhouses were studies in teak and brass. On the *Shinnecock*, the gleam of electronic navigation devices, video display terminals, and echo sounders makes the mechanical compass, with its greying sunburst of points, look of secondhand issue. Not necessarily obsolete, says Hand of the compass as he cranes to spot it in its niche, but at least 30 degrees off the last time he looked. He admits he'd be hard put to navigate the *Shinnecock* by compass, sextant, or star anywhere outside the harbor for which the ship is named. Indeed, Hand says the electronics make the difference between a marginal and profitable operation.

The *Shinnecock* typifies the industry's plunge into high technology. The process began in 1976, when Congress passed the Magnuson Fishery Conservation

PHOTOGRAPHS: TERRY DOMICO, EARTH IMAGES; NMFS

Today's fishermen, such as Dave Stein aboard the *Lady of Good Voyage* (top), command a galaxy of electronic aids. For example, they look for fish using devices that process sonar echoes into color images on a video monitor. On this screen (right), the upper half represents the entire water column beneath the boat, while the lower half highlights the region near the seafloor. Very dense objects, such as the seabed and crowded schools of fish, stand out against the water's blue background.



Improved nets and trawling methods regularly bring fishermen larger catches, such as this 8,000-pound haul (far left). The lighter and stronger nets, which are easier to tow, also boost the fuel economy of boats. And research continues. In this test at the Naval Ship R&D Center in Maryland—the nation's largest test tank—M.I.T. engineers study the influence of construction materials on the performance of a full-size net rigged for flounder in New England (left).

PHOTOS: TERRY DOMICO, EARTH IMAGES; EPSCO MARINE; NMFS; CLIFFORD GOUDEY, M.I.T. SEA GRANT

and Management Act, extending U.S. control over fishing in coastal waters out to 200 miles. No longer would fleets from Russia, Japan, Norway, Germany, and other nations have unlimited access to this territory, dubbed the Fishery Conservation Zone.

U.S. fishermen had long looked on other countries' factory ships, which boast automated fishing gear and on-board processing equipment and freezers, with both anger and awe. "We resented their presence," says Chris Cornell, now with *National Fisherman* magazine. "But there was simply no belittling the advanced techniques used by these boats, including the quick, closely controlled processing of the catch that went on below decks. As catching machines, the factory trawlers were unequaled. This was fishing and gear technology developed to the utmost and, as such, it had to be admired, however begrudgingly."

These foreign fleets had taken 76 percent of the catch from waters within 200 miles of the U.S. coast in 1976—2.3 million metric tons of fish. Now they would have to pay for the privilege or be forced to do their fishing outside the conservation zone. Moreover, those who chose to remain could take only what was allocated them after domestic boats had fished their share. After 200 years the United States was staking its claim to the fisheries off its shores, and the declaration was greeted with the prevailing bicentennial exuberance. Elliot Richardson, then secretary of commerce, called the act "the most significant fisheries legislation in the nation's history," the "keystone of a national program for our marine fisheries." The act, he avowed, would allow the U.S. fishing industry to expand.

However, Richardson noted that expansion of the fleet would not occur by itself but would require "considerable technical and financial assistance." Thus, the federal government established tax-deferral programs for new vessels, and fishing boats became attractive tax shelters for investors. The government also funded research and development on fishing technology, and sponsored a technology-transfer program to import foreign methods of trawling, net construction, fishing technique, and boat design.

The fleet responded. Old wooden boats were scrapped for steel-hulled trawlers. Vessel construction jumped 70 percent in 1977. Technology that made the foreign factory ships such efficient harvesters was miniaturized and mass-produced. The hope was that a regeared U.S. fleet would begin to reap what the foreigners had been forced to relinquish. And early results were promising: the foreign catch in the Fishery Conservation Zone dropped from 2.3 to 1.7 million metric tons in 1977, and the domestic catch increased by 16 percent the following year.

Many U.S. fishermen face an uncertain present and a mortgaged future.

Troubled Waters

But some discouraging words were also heard. Resource economists wondered aloud whether demand for seafood was sufficient to maintain prices for the fleet's increased catch. Biologists questioned whether the fisheries could bear up under the increased harvesting made possible by the new boats and advanced technology. There were more fishermen using better equipment—but there are only so many fish to catch. As Frederick Bell, former chief of economic research for the National Marine Fisheries Service, pointed out, the fisheries are an economic anomaly: "The greater the demand for a particular fishery product, the sooner less and less will be produced." The result, he said, would be depleted fish stocks, rising costs, and ultimately decreased income for fishermen.

The Magnuson Act did call for conservation measures to protect the fisheries. But effective management was impossible, Bell argued, without controlling the number of fishing vessels. However, the idea of limiting or licensing fishing boats unnerved those who viewed the oceans as common property.

The worries proved justified. Stocks of coastal ground fish—flounder, cod, and haddock off New England; halibut off the Pacific Northwest—were quickly depleted. Indeed, the New England fisheries had been in bad shape from overfishing to begin with; that was a major factor prompting enactment of the 200-mile limit. Shellfish grounds in the Northeast and Gulf of Mexico became increasingly crowded with boats. And today in Alaska, $3 million vessels sit waiting for the stocks of king crab to reappear.

Off the coast of Florida, "roller-rig" fishermen have been accused of depleting kingfish and Spanish mackerel. Roller rigs are hydraulic winders that bring in the nets. They allow smaller vessels to use larger nets—perhaps 1,200 feet long with a 40-to-60-foot opening. In 1982, four roller-rig boats journeyed north to Chesapeake Bay to net bluefish. Using airplanes to spot schools of bluefish from above and echo sounders to locate the fish from below, these boats outdid the entire Chesapeake Bay bluefish fleet, harvesting 760,000 pounds of fish in only ten days. Virginia quickly passed legislation prohibiting use of the nets.

Along the Gulf, in an area that saw the greatest increase in vessel construction, shrimp boats today go unused and unsold. Bell, now professor of economics at Florida State University, says the shrimp industry, spurred by federal incentives, developed the capacity to catch three times the available stocks. But even with more boats, Commerce Department figures show that the annual shrimp catch never surpassed 1977 levels. Losses are parlayed. Gulf boats make their way around the tip of Florida and crowd into already competitive Atlantic fisheries. More loans are needed to buoy failing operations. And when shrimp stocks make a strong showing, as they did three years ago in the Gulf, the high-tech boats produce such high

yields that shrimp prices collapse. "We have not yet come off the roller coaster of boom and bust," says Bell.

Thus, many U.S. fishermen face an uncertain present and a mortgaged future. Statistics from a recently released study by the National Marine Fisheries Service tell the story. The number of vessels in New England's trawl fleet grew from 590 in 1976 to 892 in 1981—an increase of roughly 50 percent. However, the value of the fleet's total catch increased by only 30 percent, adjusted for inflation. The result, according to the NMFS report, was "a general decline in the inflation-adjusted gross receipts per vessel."

New England fishermen were falling behind in another way as well. In 1976, the interest paid on boat loans at Gloucester and New Bedford, New England's major fishing ports, represented between 1.2 and 11.1 percent of the vessel's revenues after fuel expenses. By 1981, interest charges amounted to 20 percent of revenues.

Problems to the North

Canadian fishermen are also troubled. In 1982, Canada's Task Force on Atlantic Fisheries expressed concerns similar to those of the U.S. fishing industry, but with greater urgency. Only five years after applauding passage of their own 200-mile limit, the Canadians found their fishing industry on the verge of collapse—"mired in financial crisis, plagued by internal bickering, beset with uncertainty about the future, and divided on how to solve its problems." The task force's report singled out what it considered the industry's fundamental problem: "To get a bigger share, a fisherman is naturally motivated to get a bigger, faster, and more expensive boat. There is nothing irrational in this. But the result is more fishing capacity trying to catch the same amount of fish . . . When everyone competes for a share of a common but limited resource, the result is a zero-sum game; one man's gain is always another's loss."

The Canadian government had already tried to regulate the industry by limiting the size and kind of gear that could be used. The goal, the task force noted, was to "keep the race fair." But the fishermen balked. "Rules designed to control the tendency toward excess harvesting capacity are seen to be artificial and arbitrary and are often not successful," according to the report. The task force decided that the notion of ocean resources as common property is no longer viable on political, economic, or conservation grounds. Thus, the committee recommended that entry into the fishery be licensed and limited, and the Canadian government has started to move in that direction.

"When everyone competes for a share of a common but limited resource, the result is a zero-sum game."

The report rekindled the debate over limited entry in the United States. But that concept raises cries that the waters are free to all, cannot be owned, and should not be licensed, and that the government's limiting entry would be a blow to free enterprise. Thus, managing the fisheries has largely taken the form of what critics call "legislating inefficiency" by limiting technology. However, this serves to reduce an individual fisherman's productivity, while the costs of fuel, labor, and vessel maintenance continue to rise. What's more, such measures often do the fisheries little good. At a meeting of resource economists and fisheries scientists at the University of Rhode Island in 1981, the conclusion, according to one participant, was that "we are incurring substantial costs for management with little improvement in the economics of the fisheries."

In the waters off New England, for example, passage of the 200-mile limit seemed to bode well for the dwindling stocks of cod, haddock, and flounder. The National Marine Fisheries Service, hoping to protect the resource and control prices, set annual quotas on the amount of fish that could be harvested. However, the fleet met the quotas well before the year ended, leaving the boats with nothing to fish for and devastating fishermen relying on season-long catches to pay their costs.

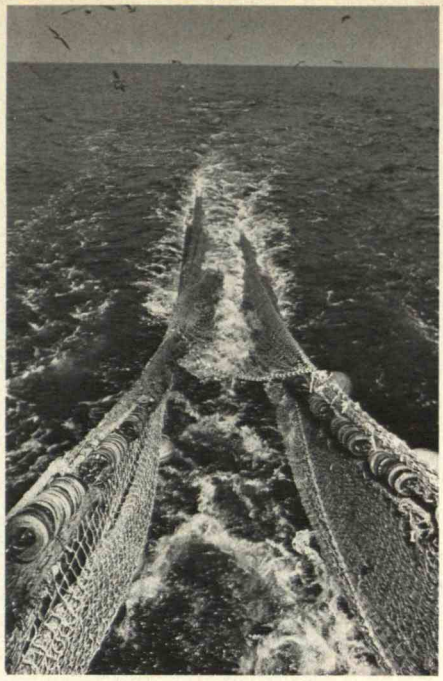
So the quotas were lifted in the hope that the market would limit the catch. However, biologists soon found that the stocks were becoming severely depressed. For example, NMFS scientists reported in early 1983 that stocks of haddock may decline by more than 50 percent by 1985. Some fishermen seemed willing to accept such depletions, feeling that boom-and-bust cycles are part of the industry, and that they weed out the unfit and the purely speculative interests. But fishery managers moved on to yet another strategy.

As of March 1983, trawlers could use nets with a larger mesh size only and keep cod and haddock of a minimum length only. The hope is that enough fish—especially young fish—will slip through the nets to preserve the resource, but not enough to bankrupt fishermen. However, Peter Colosi, the New England resource policy analyst for NMFS, is pessimistic. "The signs don't look good," he says. "The size of the stocks has just not increased, compared to the harvesting capability of this high-technology fleet. If we lived in a world where we were able to remove vessels from the fleet, we could undoubtedly make things better."

Limited-Entry Backlash

In the halibut fishery off the Northwest coast and Alaska, government attempts to establish limited entry have met with strong resistance. In 1976, fishermen in the Gulf of Alaska caught 14 million pounds of halibut in 96 days. But according to A.D. Chandler, Pacific editor of *National Fisherman*, five years later the fleet took only 16 days to harvest 14.7 million pounds. When the National Marine Fisheries Service and the President's Office of Management and Budget proposed a moratorium on further entry, the Alaska legislature drafted a resolution deploring any federal restrictions on the number of vessels or people in the fishery.

PHOTOGRAPHS: JERRY BERNDT



American fleets have adapted the technology of fishing gear that made foreign factory ships so successful.

"Fishermen know what's best for the fishery," goes the persistent plea of harvesters beseiged by what they see as evermore-exacting restrictions. If quotas are to be set, they argue, then set them for the sake of the resource, but leave fishermen to rise and fall on their own merits. They often complain that well-equipped vessels financed as tax shelters compete with traditional fleets when resources are abundant. But the new boats can be sold—or even sunk—without financial jeopardy when resources are scarce.

Yet with both the Canadian and American experiences with the 200-mile zone now documented, and with Canada already preparing a coastal-fisheries licensing program, fishermen and scientists alike are reluctantly accepting the idea that some form of limited entry will become necessary. Clem Tillion, former chairman of the North Pacific Fishery Management Council, likens the current situation to the problems of settling the West. "The cowboys put up fierce resistance to the introduction of barbed wire," he told *National Fisherman*. "But in the end, the common grazing lands were divided into sections and turned over to private owners." The result, he says, was that "this country was assured a constant supply of low-cost, high-quality beef for generations."

Fish in Living Color

Tillion and others maintain that there is no turning back from technology. "It's a tough situation with no easy answers," says Clifford Goudey, a fisheries engineer in M.I.T.'s Sea Grant Program. "But the fishermen out there are trying hard to be as efficient as they can be, and they should have access to whatever can cut costs and improve their catch." And indeed, gear for locating and harvesting fish—already remarkable—continues to advance. Electronic navigation and echo-sounding devices such as those aboard the *Shinnecock* are perhaps the most conspicuous additions to fishing boats.

Using Loran—a device for long-range navigation that measures the time delay between signals sent from two separate stations—Danny Hand can determine his boat's position to within about 50 feet. Before leaving port, he enters the coordinates for the desired trawl destination into the Loran. The device then continuously updates the boat's progress toward that destination, indicating "speed over the bottom," distance remaining, and estimated time of arrival. Along the way, Hand scans the depths using a fishscope sonar. Schools of fish can be marked on a video plotter, with the coordinates stored in the plotter's memory should he decide to return.

Once at the chosen destination, the video plotter takes over much of the tedious work required to monitor and maintain the sweep of a trawl and then repeat the course. For example, Hand can enter into the plotter the coordinates of places where his charts indicate the nets might get hung up. An autopilot hooked up to the Loran then automatically avoids those trouble spots.

Fishermen also view the depths using color sounders such as the Chromoscope, which processes sonar echos into color on a video monitor. (Made by EPSCO Marine, the Chromoscope was developed by Koden Corp. of Japan.) The color of a target depends on its density; very dense targets such as the seabed or a crowded school of fish appear red against the royal blue of less-dense seawater, for example. And the formation and location of the echoes identify the various species. For example, shrimp appear as golden balls with a green haze of plankton. Hake produce long, straight echos, while albacore leave narrow streaks. New England scallop draggers often use color sounders to identify scallop beds whose locations they enter into the memory of their video plotter. By doing this before the scallop season opens, the draggers avoid the usual trial-and-error dredges previously used to find the shellfish.

U.S. coastal fleets have also adapted the technology of fishing gear that made foreign factory ships so successful. Trawl nets consist of lighter and stronger synthetic materials and are easier to tow and maneuver, cutting the boat's fuel consumption. Researchers have shown that fish are not trapped by trawled nets so much as they are herded into them. Thus, nets with front meshes larger than the fish themselves work just as well as those with smaller meshes—and are much easier to tow. Underwater studies have revealed the best towing speeds for various species and the net "opening angles" that catch the most fish. Echo sounders placed on the headropes of the net even allow a captain in the wheelhouse to monitor the movement of the net during a tow, and to change its position or speed if fish are seen to be escaping.

Advances in boat design also promise economic benefits. For example, a "Kort nozzle"—a duct that encircles the propellor and accelerates the flow of water—can boost a vessel's power substantially. Retrofitted with a Kort nozzle at a cost of roughly $12,000, a boat could tow a 25 percent larger net or cut its fuel use by 15 percent. Robert Sedat, a naval architect at the Webb Institute in Glen Cove, Long Island, says his studies indicate that the nozzle can nearly double a boat's profits.

"Technology development can help fishermen in another way and even help protect some depleted fishery stocks," says M.I.T.'s Goudey. "What I have in mind is better ways for going after so-called 'nontraditional' fish." Squid, for example, are remarkably plentiful and consumed avidly in Japan, Europe, and most nations other than the United States. The Japanese have perfected an automated "jigging" system that uses light to attract squid to the boat. While New England fishermen practiced hand jigging at least 100 years ago, the Japanese machine dangles 60 jigs at a time—small lures that are lowered into the

water on monofilament line. Attracted to light from the boat, the squid attack the jig and snare their tentacles on clusters of barbless hooks.

Warren Rathjens of the National Marine Fisheries Service in Gloucester calls this system "a lovely fishery—clean, efficient, and producing a high-quality product." Large vessels, using 100,000 watts of light and ten or more machines operated from a single control panel, can harvest two tons of squid an hour. But even smaller vessels using a single machine and less powerful lights can catch 4,000 pounds of fish a night.

The only limit to jigging has been the difficulty of locating the huge schools of squid, as their migrations appear to be highly irregular. However, the Japanese are beginning to track squid via a satellite launched by the U.S. National Oceanic and Atmospheric Administration. In fact, U.S. scientists developed the tracking system for fishermen going after albacore tuna off the West Coast.

When they go after squid at all, U.S. fishermen generally catch them by trawling. Some observers claim that the nets often damage the soft bodies of the squid, producing a lower-quality product. But many U.S. fishermen note that trawled squid, if processed and frozen quickly, are being accepted in some foreign markets. Ironically, because American consumers have been slow to take to squid, U.S. fishermen, who once pressed so hard to exclude other nations from American waters, are now entering into joint ventures with these same foreigners. The U.S. boats trawl for squid and then transfer their catch onto foreign freezer vessels at sea. At the same time, the few U.S. squid processors, protesting such deals, have begun looking for ways to get high-quality product of their own. For example, a firm in Newark, N.J., sends a mobile freezer to Long Island fishing ports to process squid directly from the fishing boats.

The overall role of technology, however, will turn on how regulators decide to manage the fisheries. Frederick Bell argued in 1976 that the industry needed not a declaration of independence but rather a kind of offshore Homestead Act to bring its resource under closer control. Many in the industry have resisted, often with the best of intentions. But those who fail to recognize that commercial fishing is changing and needs updated management may bear out Garrett Hardin's classic warning: "Freedom in a commons brings ruin to all."

BRUCE D. STUTZ is a free-lance writer in Brooklyn, N.Y., and a correspondent for National Fisherman.

The Entrepreneurs' Story

Continued from page 9
percent to 20 percent. They felt that because of these changes, the high technology industry is now "awash" with venture capital.

Almost all of those interviewed were very skeptical of state and federal venture capital, although some thought that state seed money could be helpful. The founder of a medical-instruments firm summed up the general attitude toward government financing by saying, "Don't make it too easy for entrepreneurs. Otherwise, you won't get real entrepreneurs."

Some of the firms had received government assistance, mostly through the Small Business Administration. But most felt the assistance was "not really necessary" or "more trouble than it's worth." The founder of a CAD/CAM firm who had benefitted from a variety of state and federal financing programs said, "I wasted a lot of time trying to nickel and dime it. Basically, we are in a capitalistic society, and things work best that way." Several entrepreneurs had this advice for governments who want to help them: "Don't screw it up. Just leave us alone."

These executives evinced strong support for the 25 percent federal R&D tax credit established in 1981. They suggested that this credit be made permanent and extended to cover software development. A few entrepreneurs suggested that the federal government could promote financing for new ventures by allowing investors to write off the companies' losses on their personal tax returns during the first few years of operation.

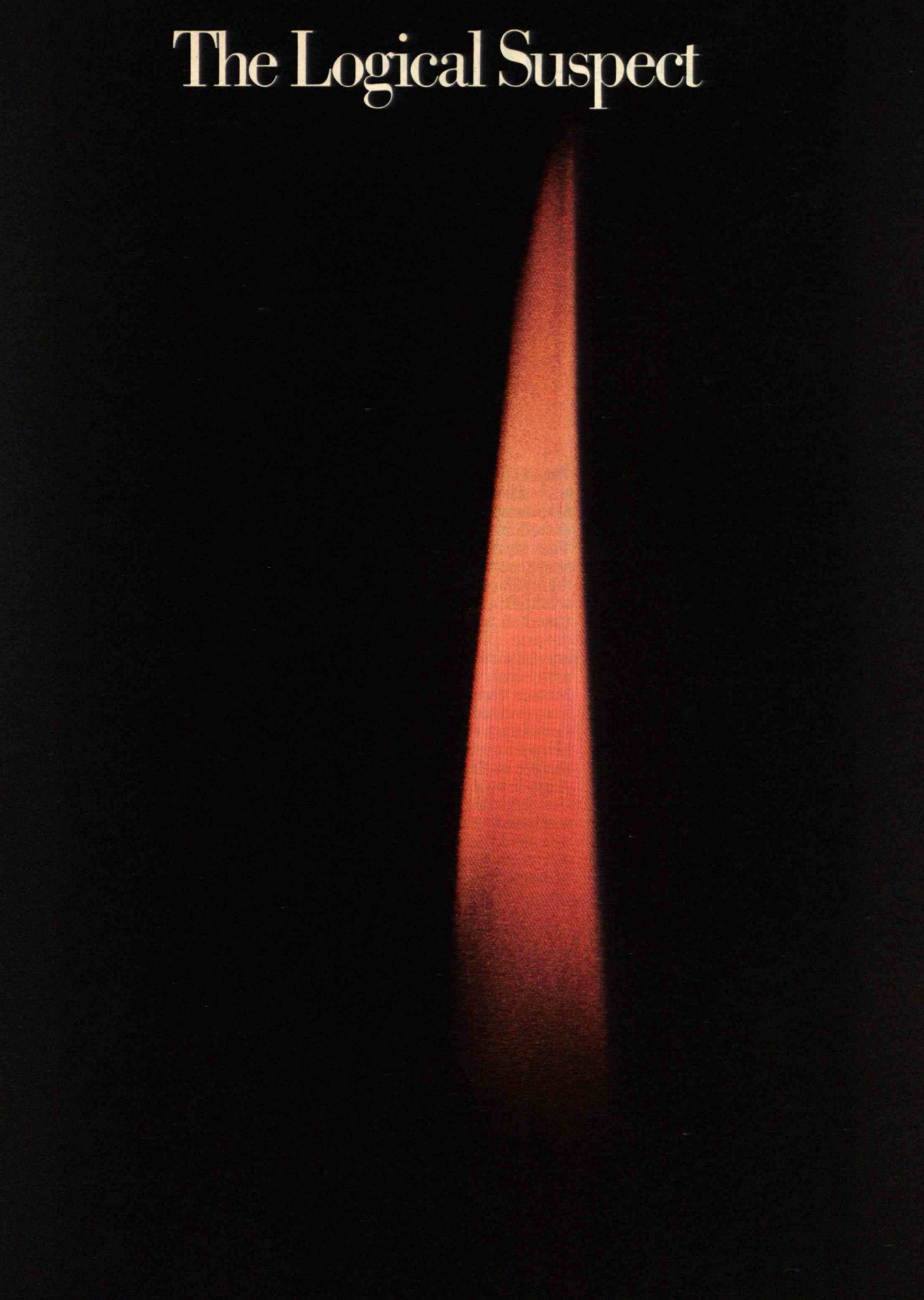
On the issue of environmental regulations, about 90 percent of the entrepreneurs felt that the "mountains of paperwork" they had to confront were a nuisance but not a serious problem. In fact, many supported environmental laws because they improve the quality of life. A maker of electronic components observed, "A startup or anyone else should meet their social obligations." Another maker of medical equipment trenchantly remarked, "I don't want to go boating on the river and have the bottom of the boat fall out."

Many entrepreneurs did criticize the "gross corruption" and "inefficiency" of Massachusetts state government. Several firms identified state labor laws and "blue-sky" laws, which restrict private investment in new firms, as regulations that were particularly damaging to high-technology startup companies. Although corporate taxes were a nonissue among these entrepreneurs, many did feel that Massachusetts income and property taxes were too high. High taxes, they said, hurt their ability to recruit skilled professionals. One entrepreneur who had founded several firms and now has over 300 employees in Massachusetts said, "We will make long-term plans to move out of Massachusetts because of the exorbitant tax levels here."

The entrepreneurs stressed one other point: high-technology development takes time. Massachusetts needed three decades to reach the stage it is at today. Other communities hoping to emulate Route 128 should remember that quick results are impossible, and that excessive expectations will surely be disappointed. □

MARK TEMPLER will receive a B.S. in physics and an M.S. in political science from M.I.T. this June. He will attend Oxford University on a Marshall Scholarship this fall.

The Logical Suspect



The Logical Suspect

Soot particle growth as it takes place in wood-burning fireplaces, diesel engines, and industrial furnaces, has been attributed to a complex set of interdependent chemical reactions. A researcher at the General Motors Research Laboratories has demonstrated that the decomposition of a single species is primarily responsible.

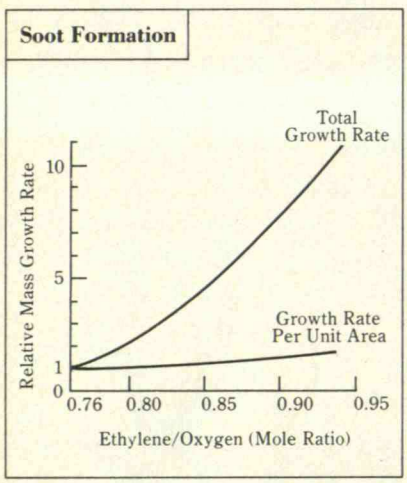
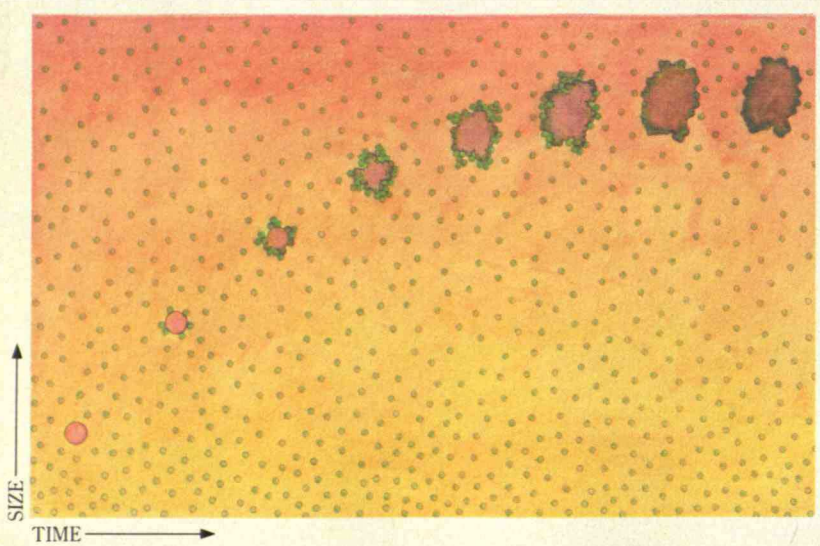


Figure 1: Total growth rate contrasted with growth rate per unit area plotted as a function of ethylene/oxygen mole ratio measured at a given height above the burner face.

Figure 2: Artist's rendition of the surface growth of a single soot particle by the incorporation of acetylene molecules.



SOOT FORMATION may be divided into two stages. Microscopic soot particles are generated in the "inception" stage. They reach full size in the "growth" stage, which accounts for more than 95% of their final mass. Most scientific exploration has concentrated on particle inception which, despite all the effort, remains unexplained. Dr. Stephen J. Harris, a physical chemist at the General Motors Research Laboratories, has reversed traditional priorities. Combining experiment with logic, he has formulated the first quantitative explanation of the growth stage in soot formation.

Dr. Harris arrived at his mechanism through an elaborate process of elimination. To focus on the chemistry of soot growth, he began by eliminating from his investigation the complexities introduced by turbulence and mixing. He limited his research to premixed, ethylene/oxygen, laminar flames with one-dimensional flow.

Previous descriptions in the literature told him that two processes take place simultaneously during growth. Incipient particles collide and coalesce into larger particles, while growing at the same time by incorporating hydrocarbon molecules from the burned gases.

The first process reduces total surface area without changing total mass, while the second, called "surface growth," increases both total surface area and total mass. Hence, the increase in the total mass of soot can be entirely attributed to surface growth.

Dr. Harris set out to identify the hydrocarbon molecules—or "growth species"—responsible for surface growth. Increasing by increments the richness of the flame, he made the key discovery that although the total mass growth rate (gm/sec) increases strongly when the ratio of ethylene to oxygen is increased, the mass growth rate per unit surface area ($gm/cm^2/sec$) increases only slightly (see Figure 1). Thus, the controlling variable for how much soot is formed is not the concentration of growth species, but the surface area available for growth.

This finding led him to conclude that richer flames produce more total soot because they gen-

erate more particles in the inception stage. More incipient particles offer greater initial surface area for the incorporation of hydrocarbons.

Since the growth rate per unit area must depend on growth species concentration, this concentration must be similar from flame to flame. Dr. Harris went on to reason that there must either be enough growth species at the outset to account for the total soot growth in the richest flame, or the species must be rapidly formed within the flame from another hydrocarbon present in high enough concentration.

HE NARROWED his search to the four most abundant classes of hydrocarbons found in flames: acetylene, polyacetylenes, polycyclic aromatic hydrocarbons (PAH), and methane. Methane can be eliminated, because its concentration does not decrease as soot is produced. There is not enough PAH to account for soot formation in any flame. Neither of these two hydrocarbons can be readily formed from the other major species present. That left only acetylene and the polyacetylenes.

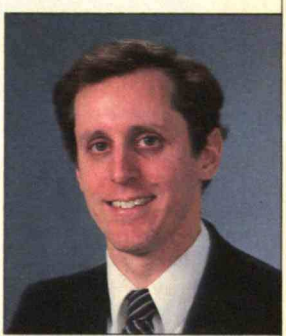
Acetylene contains enough hydrogen to account for the hydrogen content of soot measured in the early stages of growth. But among the polyacetylenes, only diacetylene could possibly supply enough hydrogen. That left acetylene and diacetylene.

There is more than enough acetylene to account for the mass of soot produced. There is not enough diacetylene, and while diacetylene can be formed from the abundant supply of acetylene, the reported rate of conversion is too slow for diacetylene to play a significant role. That left only acetylene.

Dr. Harris verified that acetylene is the growth species by determining that the slight increase in growth rate per unit area is proportional to the increase in acetylene concentration (see Figure 1). He also found that the rate constant he measured was in agreement with the reported rate constant for the decomposition of acetylene on carbon. These findings confirmed his hypothesis that soot particles grow in flames by the incorporation and subsequent decomposition of acetylene.

"Now that we know how soot grows," says Dr. Harris, "we can examine how it begins with greater understanding. Then, perhaps our knowledge will be complete enough to suggest better ways to reduce soot."

THE MAN BEHIND THE WORK



Dr. Stephen J. Harris is a Staff Research Chemist at the General Motors Research Laboratories. He is a member of the Physical Chemistry Department.

Dr. Harris graduated from UCLA in 1971. He received his Master's and Ph.D. degrees in physical chemistry from Harvard University. His doctoral thesis concerned Van der Waals forces between molecules. Following his Ph.D. in 1975, a Miller Institute Fellowship brought him back to the University of California, this time at Berkeley, where he spent two years studying laser-induced chemistry. He joined General Motors in 1977.

Dr. Harris conducted his investigation into soot particle growth with the aid of Senior Science Assistant Anita Weiner. His research interests at GM also include the use of laser diagnostic techniques in combustion analysis, with special emphasis on intracavity spectroscopy.

Continued from page 17

in a mechanical era is actually a liability in this period of electronics . . . While 20-ton electric power generators can take years to build and last decades, the life cycles of the computer can be measured in two or three years." And National Socialism not only crippled German science; it destroyed the investment-banking establishment as well. Thus, bankers in today's Germany are far less willing to take risks than their counterparts in the United States and Japan.

Nussbaum ties the Soviet Union's lack of progress in bioengineering to the Lysenko era, when Stalin championed horticulturalist Lysenko's theory that environment, not heredity, makes the organism. Nussbaum concludes that "two whole generations of geneticists trained in modern science were gone from the Soviet Union, and the country was as prepared for bioengineering as Zaire."

Which countries *will* make the transition to the new world economy? "Certainly not China, nor Nigeria, nor Egypt, probably not Mexico, nor India nor the Philippines, although they have a chance, and maybe, just maybe, Brazil, South Korea, Taiwan, Hong Kong, Israel, and Singapore," says Nussbaum. He sees little hope for any countries whose leaders are unwilling to pursue technological advance because of threats to their own power.

Of course, the Japanese will be eminently successful in adopting the new technologies. However, Nussbaum resurrects a key question about the Japanese: can they create? Unlike many other observers, he sees "the group nature of Japan's social organization as its Achilles heel. . . . The need for group conformity and consensus before acting and the desire never to be ahead of anyone else act as a major deterrent to individual creativity."

Competent Copycatism

In contrast to the freewheeling style of American high-technology entrepreneurs, Japanese business leaders are handicapped by their seniority system and the society's reliance on rote memorization in school—both deadly enemies of original thinking. Nussbaum quotes Keichi Takeoka of Matsushita Electric, maker of Panasonic and Quasar products, as admitting: "Japanese education is discouraging in developing something from nothing. We have to retrain graduates from universities."

Does this mean the Japanese can never shake the cultural disadvantage of competent copycatism? Not necessarily. From Francis Xavier to Douglas MacArthur, Japan has had to deal with major cultural shocks that dislodged outdated chunks of society, such as the samurai system. Through it all, the country has retained its essential "Japaneseness."

Indeed, Japan may already be moving away from its stereotype. The country is building a "science city" where 10,000 scientists and engineers will work strictly on inventions. Even more important, corporations such as Sony, Hitachi, and Toyota are spending appreciable sums of money on basic research. As Nussbaum says, "Here, perhaps, is the beginning of a new kind of Japanese, one who prefers to be

outside the group, to work alone, and, perhaps if Japan is lucky, to be able to chart his own way and create." *The Fountainhead* may yet be a best-seller in Tokyo. Ironically, while the most forward-looking elements of Japanese industry are calling for more individual effort and creativity, copycats here in the United States would like to borrow the most cumbersome aspects of the Japanese system.

Manifest Destiny

The United States can be divided into three areas of technological development: the dazzling high-tech crescent stretching from Silicon Valley through Arizona to Texas, with important outposts in the Boston area and other Eastern cities; the old industrial heartland; and the American Third World, which includes the older U.S. cities and most of the South. Nussbaum says that the old Confederacy followed a development pattern similar to that of India and the Philippines.

He foresees a renaissance of the U.S. economy, although it will be painful and traumatic. After all, such a rebirth will require political as well as technological change, making industrial policy the dominant domestic concern in this century. Nor is the U.S. destiny manifest. "It is quite possible," Nussbaum concludes, "that the dynamism and drive of the new high-tech Pacific frontier will be smothered in the angry reaction of displaced workers and the dispossessed poor." After all, 200,000 U.S. auto workers may never see the inside of a car plant again.

Like Robert Heinlein and Gerard O'Neill, Bruce Nussbaum throws out far more ideas than he analyzes in depth. However, although some readers may disagree with his conclusions, his premises are difficult to discount.

Because the ground Nussbaum is covering is constantly shifting, much of *The World after Oil* will be outdated in a few years. But, for a well-reasoned account of where we are today, readers need look no further. □

Jack D. Kirwan is assistant editor of The Energy Journal, *published at the University of Arizona in Tucson.*

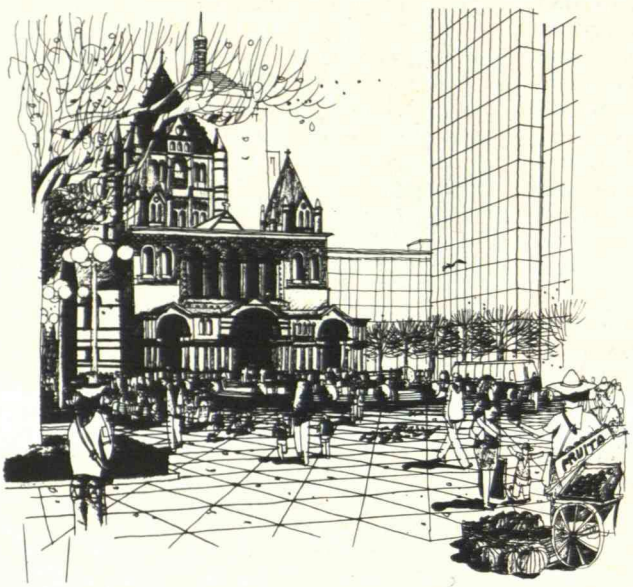
A Better Public Square

Boston has more than its share of renowned architecture, and one of the city's most fortunate places in this respect is Copley Square. To the north the arches and pointed roofs of Trinity Church rise in patterns of light- and dark-brown stone. Opposite stands the granite facade of the Boston Public Library, a grand nineteenth-century re-creation of a Roman palace. To the side the blue-green mirror wall of the John Hancock tower reflects the surroundings and the sky. But Copley Square itself is hardly one of the nation's premier open spaces. It is a sunken expanse of concrete, often windswept and deserted.

That is changing. Last year was the hundredth birthday of the square, and the Copley Square Centennial Committee, composed of local business people, residents, and city officials, asked Thomas Piper and others at M.I.T's Laboratory of Architecture and Planning to help figure out a way to build a better square.

First, Piper and his staff studied the problems of the existing square, and found plenty. The present plan resulted from a design competition in 1965. At that time, planners were so enamored of using open stone plazas to create a setting for buildings that they ignored the needs of pedestrians. In fact, designers in that competition were required to submit aerial but not ground-level views. "Copley Square is great looking from the thirty-fourth floor," notes Piper, "but it doesn't work on the ground."

The sunken central area is partly walled off from the street. The thinking of the sixties held that such a design would create a haven from the city, but it hasn't worked that way. Copley Square's divorce from the street makes people consider it unsafe, says Boston Police Sergeant Thomas Maloney. Nothing very terrible actually happens there—mostly, street people put pop bottles in bags before redeeming them at the local supermarket. But those on the higher rungs of the social ladder do not seem to find the square very inviting.



This redesign for Copley Square in Boston, proposed by the SWA Group, was one of five finalists in a competition to make the area more enticing.

"As far as sitting goes, Copley Square is about as woefully inadequate a public place as I have ever seen," says William H. Whyte, director of the Street Life Project in New York and author of numerous books, including *The Social Life of Small Urban Spaces*. When people do sit in the square, they tend to perch on top of the wall, says Piper, and they invariably watch the street. Most of the benches that do exist in the square are on the inside of the wall, facing an expanse of stone that Piper compares to the approach to an airplane hangar.

This barren square has too few trees to provide shade from Boston's sultry summer sun. On top of that, Robert McCoy, Boston's parks commissioner, admits that "we just don't have the resources to maintain Copley Square the way we would like to."

The Solution

The Centennial Committee held four public forums to discuss these problems and seek solutions. According to one school of thought, activities such as a cafe or skating rink would draw people to the square. But in the end the committee sided with Whyte's simpler vision. What are the three main functions of a square? "One: a place to sit, to rest, to catch the sun, to watch people go by. Two: a place to walk through. Three: a place for activities [such as a cafe or rink]. I don't think there is a conflict among these, but I do think one should get the highest priority, and that is the first."

On the basis of the meetings, the committee established guidelines for a new design competition, administered by the Boston Redevelopment Authority and funded by a grant from the National Endowment for the Arts. The 1966 competition had no such guidelines, says Piper—planners just took pencil to paper and drew. The winning design of the new competition will be chosen in May, but all five finalists—selected from some 300 entries—reflect the guidelines.

All these plans raise Copley Square back up and improve its relationship to the street. All include plenty of seats, groves of trees, and paths along the square's major pedestrian routes. One design has a reflecting pool near the library; another has a grass square to "evoke the symbolism of Boston Common."

The committee believes that such a square will work, despite (or perhaps because of) its essential simplicity. People should no longer consider Copley Square an unsafe enclave, and they will be able to watch the street life. Paths through the square—particularly along a route from one corner with a subway stop, busses, and shops toward the office towers—should be easier to take without ill-proportioned stairs cutting diagonally across the route. There will also be a sidewalk cafe, a small gathering place, and room for a farmers' market that already uses the square. The idea is to recreate something like the "public

ILLUSTRATION: SWA GROUP, PHOTO: MIT PRESS

spaces in older cities, particularly in Europe," says Thomas Adams of the SWA Group, one of the finalists.

The Centennial Committee and the Boston Redevelopment Authority are seeking some $3 million in public funds and private grants to build the new square, as well as an endowment fund for maintenance. They will establish a joint public-private group to manage the square, like the one that already oversees Boston's Post Office Square.

"I served on the jury in 1965 and I'm not sure what we did wrong," notes former Boston deputy mayor Katherine Kane. But Piper believes he knows: the designers failed to watch how people use squares. Because that has changed this time, he believes the new Copley Square should still be quite suitable 20 years hence.

—*David Luberoff* □

Legal Access to Sunlight

As far back as the third century A.D., solar energy was being used to heat Roman baths and greenhouses, and an entire section of civil law dealt with access to the sun's rays. Later, the "doctrine of ancient lights" became accepted in English common law. This doctrine stated that sunshine cannot be denied to anyone who has received, from "time immemorial" (defined by British courts as 27 years), enough light to read a newspaper, or just to dwell indoors "without grumbling."

In this country the legal system is only beginning to come out of the dark in protecting "solar access." Although U.S. law is based on common law, most state courts rejected the ancient-lights doctrine during the nineteenth century on the grounds that it impeded development. In the "growing cities and villages of this country," the ancient-lights doctrine would have "the most mischievous consequences," concluded a New York court in *Parker v. Foote* in 1838.

But with solar power gaining in importance, the courts are beginning to swing the other way. After listening to one of President Carter's speeches in 1977 calling for energy conservation, Glen Prah, a resident of Muskego, Wisc., installed an $18,000 solar heating system. When his neighbor, Richard Maretti, began building a house that would shade his collectors, Prah sued, asking the court to require Maretti to change his plans. Finally, in 1982 the Wisconsin Supreme Court ruled that shading a collector can constitute a "substantial" and "unreasonable" interference with the use of land, and ordered construction to be stopped. However, the court added that solar-access rights cannot be used to block "reasonable" development.

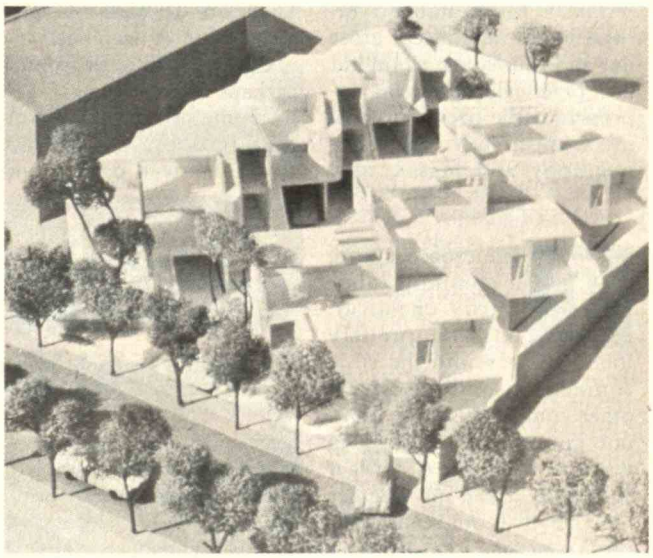
Alan Miller, an attorney with the Natural Resources Defense Council, calls this ruling "an important precedent." But he and other solar advocates believe that state and local legislation will be more important than court decisions in protecting solar access.

About a dozen states and a number of cities have enacted solar-access laws. San Diego County, Calif., requires developers to provide solar access to all homes in new subdivisions. Ashland, Ore., requires that no new construction deprive neighbors of solar access between 10 A.M. and 2 P.M.

New Mexico's law, the strongest of any state's, assures all property owners of solar access under a "prior-appropriation"—or first-come-first-served—principle borrowed from water law in Western states. Once a solar energy system is built that produces at least 25,000 Btu's per day—enough for a water heater—no later development may block its sunlight. New Jersey mandates that localities provide for solar access in zoning ordinances. And California prohibits planting new trees that will shade neighboring solar collectors from 9:30 A.M. to 2:30 P.M.

The concern of nineteenth-century courts—that protecting solar access would limit density and impede development—has not evaporated. For example, some builders have opposed the New Jersey law. And if limiting density abets suburban sprawl, some environmentalists fear that more energy will be required for transportation.

But solar access may not restrict density as much as opponents fear. Philadelphia's planning commission found that 90 percent of the city's houses already have ample solar access, and aerial photography studies in Colorado and Long Island suggest that most houses receive unobstructed sunlight during the crucial midday hours. Even in dense neighborhoods, according to *Boston Solar Retrofits* by the Energy and Environmental Policy Center at Harvard, a "substantial portion" of the homes have enough sun for solar heating.—*Janet Marinelli* □



An imaginary envelope of space above a lot, within which a building will not shade neighboring lots during specified hours, is called a "solar envelope." Architect Ralph Knowles proposes that construction codes require buildings to stay within such solar envelopes. This housing development for southern California would not shade neighbors between the hours of 9 A.M. and 3 P.M.

Safest Train in the World

The Schwebebahn, an overhead monorail in Wuppertal, West Germany, has carried 1.3 billion passengers since 1901 without a fatality.

Several train systems around the world have remarkable safety records. Superfast trains such as the Japanese Bullet and the French Train Grand Vitesse operate at speeds around 160 miles an hour with almost no accidents. Britain's "125" trains (named for the 125-mile-per-hour speeds attained on parts of the routes) often have more casualties among the track-maintenance crews than among the millions of passengers carried every year.

But no transportation system can match the long-term safety record of the overhead monorail Schwebebahn in Wuppertal, West Germany. The Schwebebahn was first built in 1901, and since then it has carried 1.3 billion passengers from Vohwinkel to Oberharmen without a single passenger fatality or serious operational accident.

The Schwebebahn overhead monorail concept arose not as a tourist attraction but as a practical engineering approach to the peculiarities of the Wupper river valley's topography and mass-transit needs. The area is hilly and the soil is rock—conditions that precluded subway construction. In addition, there were several derailments on New York's conventional elevated rail system at the turn of the century. The Germans wanted to prevent such accidents, so they built a monorail, which cannot jump its track.

The Schwebebahn operates today much as it did 80 years ago. The two-car trains hang from an elevated rail structure supported by arched triangular frames. Each train holds up to 200 passengers and costs $6.40 per kilometer to run (including both capital and operating expenses).

Compared with U.S. elevated railroads, the German structure appears to be quite light, and it does not detract from the countryside as it winds along, some 40 or 50 feet above the Wupper River. There are 17 stations—platforms open at each end.

One segment of the route is perhaps unique in mass transit. Some of the piping from chemical plants extends across the river, passing both over and under the Schwebebahn trains. The passenger has an unusual sensation of "sailing" through a complex structure of pipes and cables while swinging gently over the curves of the river.

The Wuppertal system benefits from its conservative design, moderate operating speeds, and its many fail-safe provisions. Reportedly, even a "mad engineer" could not crash a train: when two trains are in the same "block," all current is shut off.

In 1950, a circus operator rode a baby elephant on the Schwebebahn as a publicity stunt. While the train was moving, the elephant panicked, burst out of the car shell, and plunged headfirst into the river. But the Schwebebahn's safety record remained unblemished. The elephant, which was not seriously injured, was retrieved from the river and appeared in the evening performance.—*Nicholas A. Bond* □

Adapted from European Scientific Notes, *published by the U.S. Office of Naval Research in London.*

Chemical Hazards: What We Don't Know Might Hurt Us

Trichloroacetic acid, a common laboratory chemical, has frequently found its way into the environment. Combined with other compounds, it is a minor constituent of drinking water in many areas. "Yet if somebody asked me whether this chemical could cause cancer," concedes John Doull, a toxicologist at the University of Kansas who has often used the acid in experiments, "I couldn't say."

Recently, the National Research Council (NRC), a part of the National Academy of Sciences that provides advice to federal agenices, completed a study to find out how much is known about the health effects of chemicals. The researchers found that trichloroacetic acid is typical. "Of tens of thousands of commercially important chemicals," the NRC committee that did the study says in its report, "most have scarcely been tested at all."

Pesticides and drugs are the best-tested compounds, yet toxicologists have relatively complete information on health hazards for only 10 percent of the pesticides and 18 percent of the drugs in use today. One-third of these chemicals have never been tested at all for toxicity. Somewhat less well understood are food additives and cosmetics, and least understood of all are general commercial chemicals such as solvents, paints, and plastics. No tests have been performed on nearly 80 percent of them, and little is known even about the rest.

Right-to-know laws passed recently by some states and the federal government require manufacturers to provide information on the health effects of such commercial chemicals. "However, these laws don't help people when there is no information to disseminate,"

PHOTO: GERMAN NATIONAL TOURIST OFFICE, DIAGRAM: OMNIGRAPHICS

says John C. Bailar of the Harvard School of Public Health, who headed the statistical subcommittee for the NRC study.

These percentages of untested chemicals make the situation sound somewhat worse than it actually is. For one thing, inert ingredients in drugs and pesticides are unlikely to be dangerous, yet these ingredients were often counted as untested. Data on some chemicals weren't included in the NRC study because manufacturers were unwilling to divulge proprietary information. Also, many chemicals are produced in small quantities, and few people are exposed to them. Many others, such as acetic acid, an industrial chemical that is also in vinegar, haven't been thoroughly tested but have been in use for years with apparent safety.

However, such assurances must be tempered. "You ought to factor in the fact that many compounds have been around for 20 years," says Doull, who headed the NRC's toxicology subcommittee. "Still, you can't be sure that compounds for which we lack two-year animal tests don't cause cancer." Furthermore, toxicologists might like to focus on the chemicals people are exposed to most, but there is a "nearly complete absence" of data to determine which chemicals these are, according to the report. Data are generally unavailable on matters such as production volumes, manufacturing processes, numbers of workers exposed, and percentages used for different purposes. For example, a given chemical might appear in embalming fluid and plastics or in pesticides and gasoline. Keeping such proprietary information locked in files does the public little good, Bailar points out.

Toxicologists are able to reliably gauge the health effects of only a few of the chemicals in use today, according to a recent study by the National Research Council. Just 18 percent of the drugs, 10 percent of the pesticides, 5 percent of the food additives, and 2 percent of the cosmetics have been thoroughly assessed. "Chemicals in commerce"—compounds in plastics, paints, cleaning fluids, and other products—are even less understood. Toxicologists have assessed almost none of the compounds completely, and only about 20 percent in a minimal way.

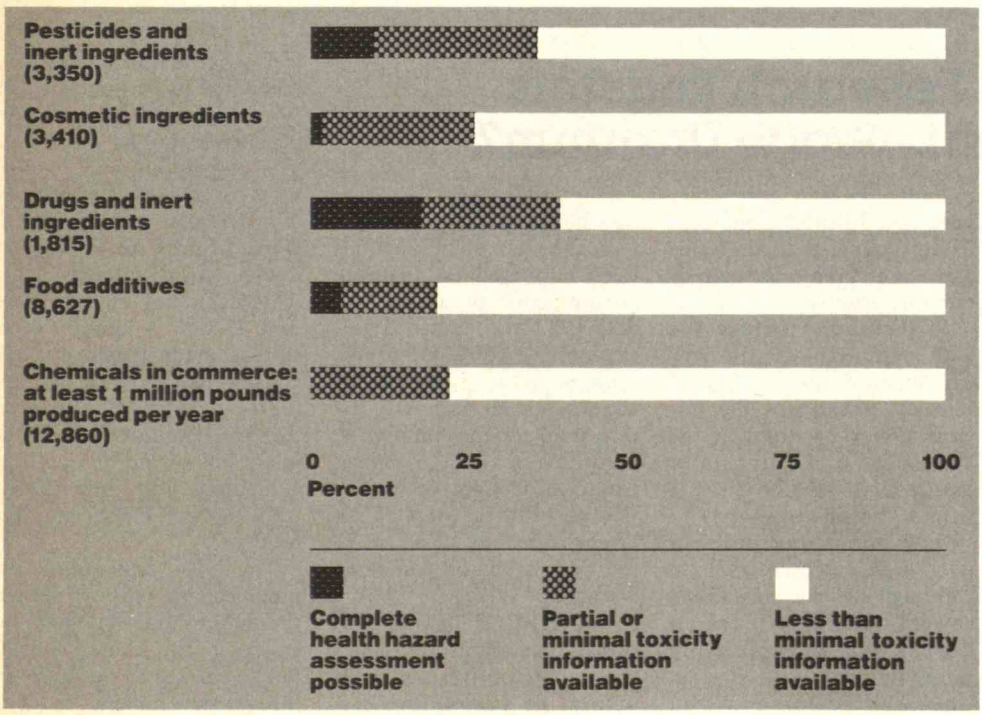
Regulatory Backlogs

The gaps in knowledge about chemicals occurred for historical reasons. Large numbers of chemicals—many as innocuous as pepper but a few as potent as the carcinogenic pesticide EDB—were in use prior to the past two decades, when strict regulations were established. The regulations required industry to test new chemicals such as pesticides and drugs thoroughly before marketing them, but not those already in use. This left huge backlogs of untested chemicals.

Agencies with limited resources are still attempting to figure out what they need to know about these backlogs. For example, the Environmental Protection Agency (EPA) is systematically checking pesticides to pinpoint tests that need to be done. By the end of this year, that task will be accomplished for 40 percent of the pesticide poundage used in the United States, according to Richard Hill, EPA assistant administrator for pesticides and toxic substances. The information should be complete by the end of the decade.

Because the public's exposure to them is usually less direct and often minimal, general commercial chemicals—those that are not food additives, drugs, pesticides, or cosmetics—are subject to the weakest regulations, under the Toxic Substances Control Act (TSCA). A company need merely give the EPA 90-day notice if it plans to market a general chemical.

The company must provide the EPA information on what the chemical is, the manufacturing process, how many workers might be exposed, and health effects, if any are known. The EPA's Office of Toxic Substances (OTS) must then estimate the dangers by determining whether the chemical is related to others that have proved toxic and how many people are likely to be exposed. If it can demonstrate a potential problem, the OTS may require tests, says Hill: "Sometimes uses of the chemical are restricted. Sometimes the notice to man-



ufacture it is withdrawn."

Critics are not sanguine about the effectiveness of this process. They point out that the EPA asks companies for extra information on few chemicals—in fact, less than 5 percent, according to Hill. "The hope originally pinned on the premarket screening process has not been fulfilled," says Ian Nisbet, a scientist at the consulting firm of Clement Associates.

Screening Chemicals

The biggest problem of all is posed by commercial chemicals already in use, as they haven't received even this much scrutiny. The NRC proposed a four-stage process to start screening these, as well as the specific categories of chemicals, to decide which are the most important to test. The potential toxicity of a chemical and people's exposure to it would first be estimated quickly but roughly. More analysis at greater cost would be conducted in successive stages in areas where potential problems appear. Arthur C. Upton of New York University Medical Center, head of the NRC subcommittee that conceived this approach, estimates that working it out in detail to determine the relatively few chemicals most in need of testing would take five years.

The NRC study was done for the National Toxicology Program (NTP) within the Department of Health and Human Services, the only federal entity that can test all classes of chemicals. Today, candidates are nominated for testing by federal agencies, industry, or the public, and the NTP tests those that appear to merit the most concern. Upton hopes that the NTP will want to implement his committee's selection scheme, thus actively investigating all chemicals rather than simply examining the few that happen to be proposed. However, Raymond Shapiro of the NTP says the staff has barely begun to sift through the results of the NRC study, let alone decide what to do about them.

Once chemicals are selected, the economic and political barriers to testing them remain substantial. Thoroughly testing a single chemical can cost $1 million. "Even if we had every toxicologist in the country at work, it would take years and years to test all the significant chemicals," says Bailar.

"Political obstacles have prevented chemicals from being tested even when there is a widespread scientific consensus that tests are needed," says Nisbet. Seven years ago he was a consultant to the Federal Interagency Testing Committee (ITC) in selecting 10 general commercial chemicals raising serious concerns. The EPA's Office of Toxic Substances should decide which of these need testing and establish rules for industry to do so. "But so far, essentially nothing has happened," says Nisbet.

Hill concedes that the EPA let a large backlog develop of chemicals proposed by the ITC for testing, but says this backlog is being whittled down. Nisbet isn't so optimistic. "In principle, rules for industry to test chemicals could be written in three months," he says, "but in the real world it is different. You get bureaucratic maneuvering that ends up in delays." He believes that the problem is the procedure laid down in the law itself—and that a federal agency could have tested the chemicals proposed by the ITC "three times over" by now. Unless the law is changed, he argues, too little headway will be made in understanding these worrisome commercial chemicals.

—Jonathan Schlefer □

Should Research Reactors Use Bomb-Grade Uranium?

About 4,000 kilograms of high-enriched uranium (HEU), enough to build about 200 atomic bombs, are in circulation worldwide. This HEU typically contains a 93 percent concentration of U-235, the isotope of uranium that drives nuclear chain reactions. Such weapons-grade fuel is not used in nuclear power reactors, which usually operate on only a 3 to 4 percent concentration of U-235, but rather is used in research reactors in the United States, West Germany, France, Japan, and 30 other countries. Many people fear that this fuel is vulnerable to theft by terrorist groups.

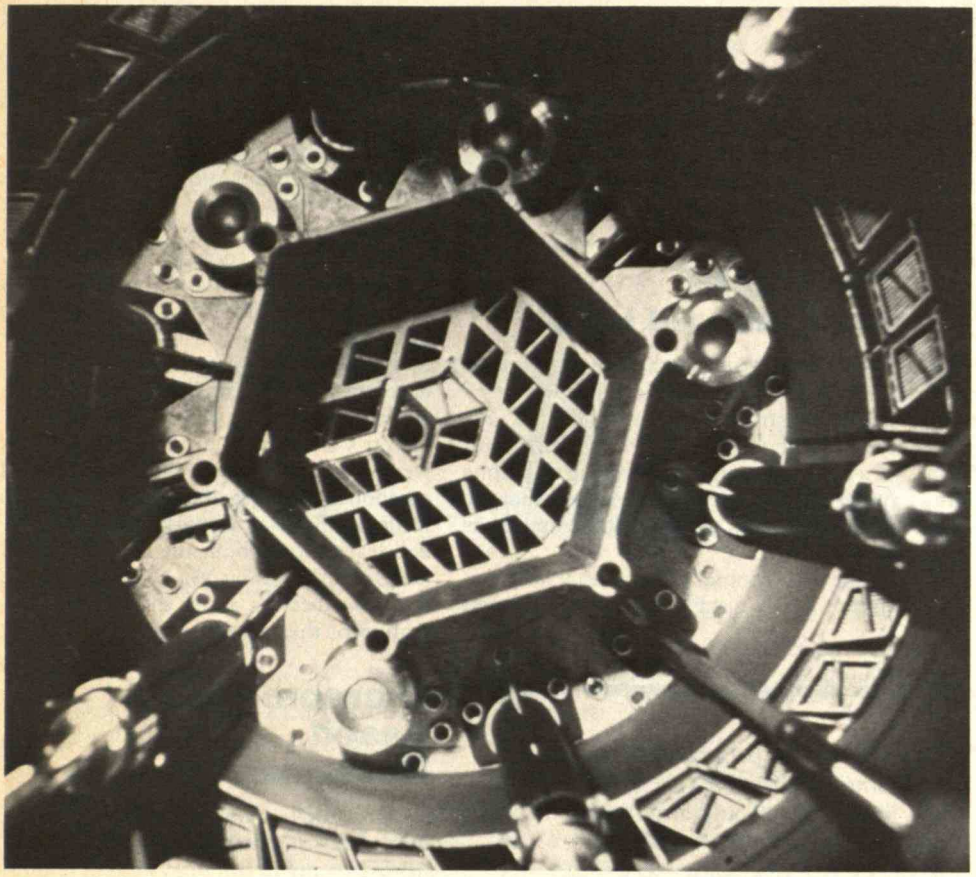
In testimony before the U.S. Nuclear Regulatory Commission (NRC), Daniel Hirsch, director of the nuclear policy program at the University of California at Santa Cruz, noted that it would "be relatively easy to steal kilogram quantities of HEU" from research reactors. Although no one has stolen any yet, Hirsch testified about "break-ins where people came and left notes saying, 'Just wanted to show you how bad your security was.' "

In the past, some HEU has been exported to unstable governments. Between 1954 and 1982 the United States exported 23,590 kilograms both to major allies and to countries such as South Africa, Iran, and the Philippines, according to data compiled from Department of Energy (DOE) statistics by David Albright, research associate at the Federation of American Scientists.

The NRC is issuing proposed regulations to reduce the amount of HEU used in reactors. At *Technology Review*'s press time these were scheduled to be published in April, followed by a 60-day period for public comment. The regulations will require most of the 25 universities with research reactors in the United States to switch to low-enriched uranium (LEU), which contains only 20 percent U-235. A bomb could still be made from LEU, according to Otto Harling, director of M.I.T.'s Nuclear Reactor Laboratory, but 250 kilograms would be required compared with only 20 of HEU—a much harder amount to amass.

The NRC regulations are intended not only to reduce the chances that HEU might be stolen in the United States, but also to set an example for foreign governments to con-

New regulations may require research reactors to stop using high-enriched, weapons-grade uranium. However, using low-enriched fuel in the core of M.I.T.'s reactor, pictured here, may not be possible.



vert their reactors to LEU, according to NRC Commissioner Victor Gilinsky. James Devine, deputy assistant secretary of state, says, "There is unanimous agreement among foreign governments and programs that reduced trade flows in HEU could help reduce the risks of major nuclear proliferation and terrorism."

Switching to LEU presents a number of problems. Foremost is the need to fit enough U-235 into the small cores of research reactors. These reactors depend on the concentrated U-235 in HEU to generate copious amounts of neutrons for experiments in fields such as medicine, geology, and physics. As James Kane, director of DOE's Office of Energy Research, explains, "Those reactors do far more than train nuclear engineers. They do good science."

Denser LEU fuels being developed and tested by the DOE should satisfy the needs of most research reactors, says Gilinksy. For example, the University of Michigan has already converted its reactor to LEU. According to Robert Burn, manager of the reactor, one aspect of performance dropped 10 percent. Although this could delay some experiments, it has hardly affected those actually performed at Michigan at all. However, M.I.T. and the University of Missouri at Columbia cannot convert their reactors even to the newer LEU fuels without a significant loss of performance or major redesign, says Lincoln Clark, M.I.T.'s director of reactor operations. The NRC's regulations will probably require that these reactors use a fuel with an enrichment between that of LEU and HEU.

Converting all reactors but those two would cost $15 million, according to the LEU Study Group established by the NRC. Although others say this estimate is highly inflated, conversion costs could well be beyond the financial resources of most universities, and it is not clear how much of the tab will be picked up by the DOE or the NRC. However, Gilinsky argues that converting reactors to LEU might save money in the long run. If there were a theft of HEU, even of too little to make a bomb, Gilinsky believes that the cost of new security restrictions would "absolutely dwarf" that of converting university reactors to LEU.

Not all scientists are sure that converting to LEU is worth the trouble. They argue that only the 5 kilograms of a research reactor's HEU that may be kept in an "unirradiated" state are actually subject to theft. The remaining "irradiated" fuel, which has been burned in the reactor, is so radioactive that it would harm or kill anyone trying to steal it, according to Clark. Thus, accumulating enough fuel for a bomb would require "multiple, simultaneous" thefts. Furthermore, building an atom bomb is a complex technological task. "It took a tremendous national effort for us," Clark says, "and I'm sure it would take the same for anyone else."

However, Gilinsky believes that some of the fuel considered irradiated actually has a "rather light level of radiation," so stealing it might not be impossible. In addition, Theodore Taylor, a former weapons designer at Los Alamos National Laboratory who is now a member of the board of the Nuclear Control Institute, says that a bomb made with the right technology requires no more than 11 kilograms of HEU—and perhaps considerably less.

Critics of the NRC regulations also point out that reactors run by the DOE, over which the NRC has no jurisdiction, actually use more HEU than university reactors in this country. However, since many of the DOE reactors are used for military purposes, their security is extremely tight. Even so, the DOE is also studying the possibility of using LEU for its reactors.

—Frank Lowenstein □

PHOTO: PAUL MENADIER

RNA in the Laboratory

After what they describe as "four or five years of struggle," Professor Philip A. Sharp and his colleagues in the M.I.T. Center for Cancer Research have achieved in a test tube, without the intervention of living cells, what Harold M. Schmeck, Jr., of the *New York Times* calls "one of the most important but mysterious of life processes": splicing together strands of ribonucleic acid (RNA).

The achievement is not unlike that of a decade ago, when DNA was first spliced in a technique that has become the mainstay of recombinant-DNA research—gene-splicing. But RNA's role is very different from that of DNA. DNA is the archive, the repository of genetic information. RNA's job is to replicate DNA in an organism to form a template for the manufacture of a cell's characteristic products.

The new achievement will make laboratory studies of RNA vastly simpler than heretofore, and as such it is a major step toward understanding the genetic system. Studies of RNA processing "will have a profound effect on our understanding of how genes are expressed" in cells, says James E. Darnell of Rockefeller University. □

The Fourth Gravitational Lens

Discovery of the fourth known "gravitational lens" was announced last winter by a team of astrophysicists from M.I.T., Caltech, and Princeton. It was the first fruit of a new astronomical surveying technique designed to locate bodies in space that are positioned so as to magnify themselves as seen from Earth.

The newly found gravitational lens consists of a very distant quasar—the faintest ever observed—whose light is focused toward Earth by an intermediate galaxy. The light passing the galaxy is bent slightly by the galaxy's gravity field, with the result that the light is intensified for an Earth-bound observer.

In addition to revealing a distant quasar that would probably never have otherwise been seen, this new lens—called 2016 + 112 for its coordinates in the sky—may make an important contribution to two other astrophysical questions: If the quasar's light varies in intensity, the fact that images of it are reaching the Earth by different routes past the intervening galaxy may enable physicists to calculate the quasar's distance from the Earth. And as we learn more about the location and components of gravitational lenses, says Professor Bernard F. Burke of M.I.T., we will learn more about the distribution of material in the universe. And this, in turn, bears on theories about the age and formation of the cosmos. □

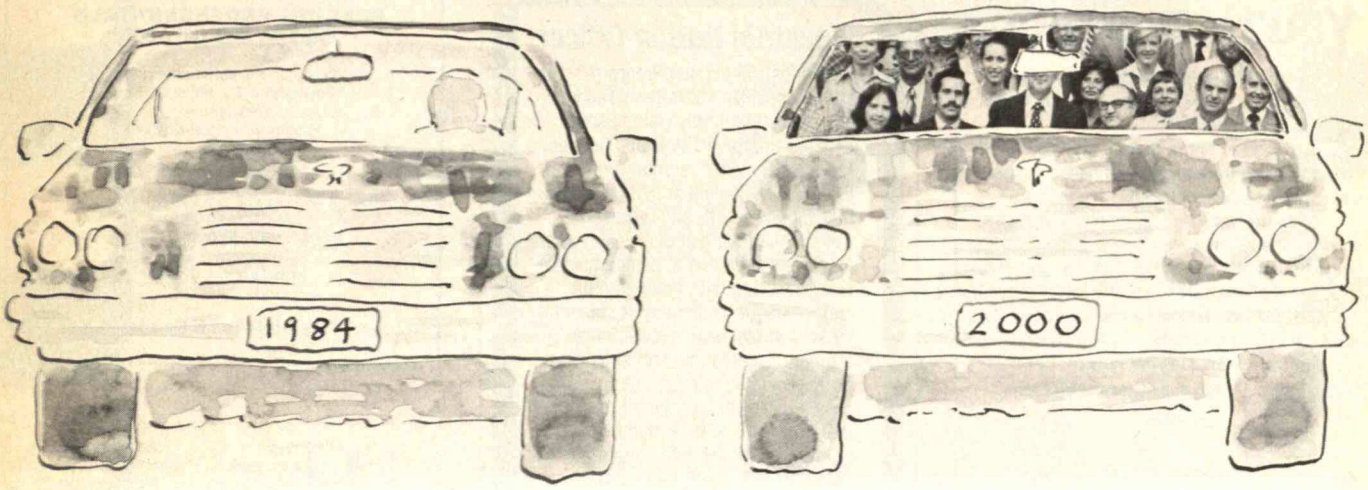
Microprocessor-Based Medicine

Conventional medical practice involves careful measurements of blood pressure, heart rate, and respiratory activity. But by Dr. Richard J. Cohen's standards, these conventional measurements are far too gross to be truly revealing. Dr. Cohen, who teaches physics at M.I.T. and works in the field of health sciences and technology, suspects there is a fine structure in these parameters that could be helpful in predicting the onset of heart attacks, even sudden infant death syndrome.

Dr. Cohen's hypothesis derives from his experiments on dogs. A microprocessor programmed to reveal short-term variations in the heart's electrical activity displayed "dramatic" changes when dogs were made susceptible to ventricular fibrillation. Dr. Cohen also finds the microstructure of heart and respiratory activity of normal babies very different from that of babies that are later victims of sudden infant death syndrome.

Cohen thinks that in these applications of microprocessing he has only scratched the surface of a vast and promising new use of technology for medicine. □

Pay-as-you-drive systems can fund improvements in mass transit that our political system is otherwise ill-equipped to generate.



Moving People and Goods

Continued from page 66

U.S. and European cities, it may increase as technological and social change belatedly comes to the rescue of human-powered vehicles. Ordinary nonathletic individuals can ride advanced bicycles at 20 miles per hour on the level for long periods. Reduced subsidies to other forms of transportation would help expand bicycle riding greatly, and the environmental and social benefits would be prodigious.

Setting the Stage for Innovations

If mass transit systems become profitable through the use of favorable transportation pricing policies, private companies might again show interest in providing such services, as they did in the nineteenth century. Incentives for technological innovation, long absent from this field, would also improve.

What new technologies might appear?

The simplest ways to improve public transportation are already proving effective in some U.S. cities. These include using express buses on superhighways, designating special lanes for buses (and sometimes for cars carrying four or more people), and reserving certain streets for buses. But we are learning that the success of these systems depends on the extent to which downtown congestion is controlled: little is gained if an express bus is locked in a traffic jam at the end of its trip.

To solve this problem, city governments worldwide are installing rapid-transit systems—mostly subways. These are the simplest form of railroad: a single line with stations situated along it. This principle hasn't changed since the first London "undergrounds" were built in the 1860s, although modern electronics have reduced the need for train operators, dispatchers, and ticket vendors.

The major unsolved problem in mass transit is finding a way to provide efficient, personal service. Although there are a number of concepts for achieving that goal, none could be in place on more than a pilot scale before the end of the twentieth century—and perhaps not for many years thereafter.

But if experiments such as those in Hong Kong and Singapore can show how to charge users the full costs of transportation, their contribution to the future of urban transport will be great. Clearly these schemes have the potential for funding improvements in U.S. mass transit that our political system is otherwise ill-equipped to generate.

If only one major nation embarked on a program to make transportation charges more rational, others, seeing the benefits, would surely follow. The increasing patronage and efficiency of mass transit would inevitably lead to the development of advanced transportation systems far more in harmony with human needs than those that now dominate our lives.

DAVID GORDON WILSON, professor of mechanical engineering at M.I.T., is well-known among transportation specialists for his interest in human-powered vehicles, including the design of a unique recumbent bicycle that he uses to commute daily to his Cambridge office.

PROFESSIONAL

You're Boxed In

Your career is blocked. You're frustrated and insecure. Time is going by and things aren't getting better.

You need to find a better way. You need new objectives for yourself and new strategies for achieving your objectives.

That's my job. I am a management consultant, specializing in change, and I have helped hundreds get out of that box and onto a more satisfying career and life path.

Call me to explore what I can do for you. There's no charge, no obligation, to explore. Don't wait. Call me now.

Riva Poor, SM Management, MCP from MIT

Private programs. Also 2-day weekend workshops. *(See p. 18 for details.)*

Riva Poor
73 Kirkland Street
Cambridge, MA 02138
Telephone: (617) 868-4447

NELSON, COULSON AND ASSOCIATES, INC.
PROFESSIONAL SERVICING CONSULTANTS

COLORADO OPPORTUNITIES

- Ph.D. Consultant: strong satellite systems background. Excellent salary, benefits and relocation!
- Aerospace Systems Engineers
- Computer Professionals
- Guidance & Controls
- RF/Microwave
- Space Communications C^3
- Maintainability Engineers-Electronics

For these and other positions, contact:

P. R. Coulson, PE, '43
NELSON, COULSON & ASSOC.
P.O. Box 1378
Englewood, CO 80150
303/761-7680

THE BEST & BRIGHTEST

Ask P'nB to Market Them Because I'm an Engineer Who Talks Your Language

Was out there myself for 25 years—from Designer to Program Manager.
An IEEE member and MIT engineer, I know what YOU want.
Send your resume, you'll be the client, with all fees and expenses paid by nationwide companies looking for the BEST and the BRIGHTEST

Marc Cutler, President
(215) 687-4056 day or night

P'nB CONSULTANTS
Box 494-T, Wayne, PA 19087
Known Coast to Coast

Industrial Liaison Officer

The Industrial Liaison Program of the Massachusetts Institute of Technology seeks two Industrial Liaison Officers to provide interface between MIT and assigned member firms. Will perform liaison activities among MIT faculty, staff, and representatives of member companies. Involves group presentations at company locations, meeting with company officials, assisting company representatives with technical questions by arranging appropriate faculty contact or by providing relevant information. In addition, will arrange on-campus meetings, solicit new members, and interact by phone with clients on behalf of MIT faculty and staff.

Candidates must have Bachelor's or Master's in relevant field, with one degree in Chemical Engineering, Electrical Engineering, Materials Science and Engineering, or Mechanical Engineering (one MIT degree preferred). Minimum two years' industrial experience, management perspective, and excellent communication skills essential. Poise, strong interpersonal skills and willingness to travel also vital. In depth knowledge of the Institute preferred.

Please submit two copies of resume, referring to Job Nos. A364, A365 to: Ms. Virginia Bishop, MIT Personnel Office, E19-220, 77 Massachusetts Avenue, Cambridge, MA 02139. MIT is an equal opportunity/ affirmative action employer.

MIT

PUBLICATIONS

NEW

From Technology Review—

Current, accurate information on today's important issues. Reprints of:

"Measuring the Intangible in Productivity," by Michael Packer

"Computer Crime," by Leslie Ball

are now available. Send $2.50 per copy plus $1.00 for postage and handling to Reprints, Technology Review, MIT 10-140, Cambridge, MA 02139

PLACING PROFESSIONALS COAST TO COAST

We are constantly searching for:
•Engineers: EE's, ME's, CHE's•
•Scientists•
•Computer Professionals•
•MBA's•
•Financial Specialists•

Submit your resume and salary history to:
MARTIN LYONS
PERSONNEL SERVICES, INC.
230 No. Main St.
Mansfield, MA 02048
(617) 339-9301

The High-Tech People

THE ACCESS GROUP, INC. — **Engineering Specialists Nationwide**

All Levels-All Industries.
ALL FEE PAID-FULLY CONFIDENTIAL.
Contact-Bill Kan, Ph.D. '58,
P.O. Box 3267
Stamford, Ct. 06905. 203-356-1166

VISITOR ACCOMMODATIONS

BED & BREAKFAST CAMBRIDGE & GREATER BOSTON CAPE COD & NANTUCKET

by Riva Poor, SM MIT
Hundreds of B&B homes, short term condos & houses, and Share-a-Homes.
LOW IN COST — HIGH IN HOSPITALITY
617-576-1492
DISCOVER HOW NICE WE CAN BE!

REAL ESTATE

VINALHAVEN, MAINE.
Waterfront, totally renovated
3-bedroom house on private cover overlooking Fox Thoroughfares and Northhaven. Available monthly, July/September. Peace, charm, water.
Caldwell, (617) 934-6998 Evenings

CLASSIFIED ADS: $15.00 per line, three line minimum. (Allow 28 letters & spaces for first line. 50 letters & spaces for each additional line.)
DISPLAY ADS: $60.00 per inch, 3 inch maximum.
COPY DEADLINE: Five weeks prior to publication date. Payment in advance of insertion required. Send orders to Classified Section, Technology Review MIT 10-140, Cambridge, Mass. 02139.

Now you don't have to be afraid of the dark.

Put even your smallest fears to rest. With Kodacolor VR 1000, the fastest color print film ever from Kodak. You don't even need a flash to turn night into one of the most beautiful times of day.

Kodak

Because time goes by.

The new '84 Ford Tempo. Technology never felt so comfortable.

The inside story.

Tempo's interior is a computer-refined compartment for five. Computer-designed placement of seats, door, roof and window areas afford maximum space efficiency.

Even Tempo's front-wheel-drive configuration was designed to provide more interior room. Since there is no drive shaft, there is no large hump to rob valuable floor space. In fact, Tempo actually has more rear room than a Mercedes 300D.*

For driver's convenience, controls are all placed within easy reach. For added ease, wipers and washer, directionals, high-beams and flash-to-pass are located on the steering column itself.

Technology that works for you.

Outside, a unique aerodynamic shape channels the wind over and around Tempo to help increase fuel efficiency. It also directs the airflow, reducing overall lift for improved stability and directional control.

Its front-wheel drive delivers all-weather traction, while its four-wheel independent suspension provides a smooth ride.

Plus, Tempo has the world's most advanced automotive computer, the EEC-IV. It processes up to 250,000 commands per second. Coupled with Tempo's 2300 HSC (High Swirl Combustion) engine, you get quick power response from a standing start and at cruising speed.

Best-built American cars.

When we say "Quality is Job 1," we are talking about more than a commitment. We are talking about results. A recent survey concluded Ford makes the best-built American cars. The survey measured owner-reported problems during the first three months of ownership of 1983 cars designed and built in the U.S. And that commitment continues in 1984.

*Based on EPA Interior Volume Index.

Have you driven a Ford... lately?

Ford